APPENDIX H: THREATENED AND ENDANGERED SPECIES AND MIGRATORY BIRDS

THREATENED AND ENDANGERED SPECIES APPENDIX

PONDBERRY ASSESSMENT

Biological Assessment for Pondberry

1 INTRODUCTION

1.1 Purpose

U.S. Army Corps of Engineers (USACE), Vicksburg District (MVK), is preparing a draft supplemental environmental impact statement titled "Draft Supplement No. 2 to the 2007 Final Supplement No. 1 to the 1982 Yazoo Area Pump Project" and is requesting concurrence with our determination that the project **"May affect, but is not likely to adversely affect"** federally endangered pondberry (*Lindera melissifolia*). This Biological Assessment (BA) specifically evaluates the potential effects of the Proposed Plan of the Yazoo Backwater Reformulation Project to evaluate whether the proposed actions may affect pondberry. If the proposed plan is modified or another alternative plan is selected, reevaluation of the potential impacts would be conducted.

The MVK submitted this BA to the U.S. Fish and Wildlife Service (USFWS) pursuant to Section 7 of the Endangered Species Act (ESA), as amended. This BA is prepared in accordance with legal requirements set forth under Section 7 of the ESA (15 U.S.C. 1536 (c)) and applicable guidance documents, and uses the best scientific and commercial information available when assessing the risks posed to pondberry by federal actions. This BA has been prepared to address all of the potential 'effects of the action' (as defined in 50 CFR 402) on pondberry that could be associated with the proposed project in accordance with Section 7 and associated implementing regulations (50 CFR 402). The BA includes the description of the Action Area, proposed actions, species account and status, effects of the proposed actions, mitigation and conservation measures, and effects determination. Pertinent biological and ecological data for pondberry is based on published and unpublished literature, communication with experts, and findings of recent U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL), studies.

The USACE completed a prior BA (USACE 2005) for the Yazoo Backwater Reformulation Project and concluded that implementation of the Yazoo Pump Project was not likely to adversely impact pondberry on the Delta National Forest (DNF). That assessment was based on research into impacts of backwater flooding and localized hydraulic regimes on the current distribution of pondberry (U.S. Army Corp of Engineers, 2000b, 2000c, Lockhart et al. 2009). In its 2007 Biological Opinion, the U.S. Fish and Wildlife Service (USFWS) did not concur with USACE findings regarding the relationship between flooding and pondberry, concluding that the magnitude of reduction in flooding by the Project likely would adversely affect pondberry. At the heart of the disagreement was the role of hydroperiod on the distribution, growth, and development of pondberry, and the need for improved knowledge on pondberry biology and ecology. Subsequently, the MVK provided funding to the U.S. Forest Service (USFS), Southern Research Station, Center for Bottomland Hardwoods Research, to investigate a wide array of research topics, including biology, ecology, and ecophysiology of pondberry. The USACE was particularly interested in effects of light availability (which *in situ* for pondberry is influenced by canopy and midstory cover) and hydroperiod on growth and development of pondberry. Results of a plethora of these investigations are included in this BA.

1.2. Authorities

- The proposed project is authorized by the Flood Control Act of 18 August 1941.
- Fish and Wildlife Coordination Act (16 U.S.C. 661-667e; the Act of March 10, 1934; Ch. 55; 48 Stat. 401), as amended
- Endangered Species Act (1973), as amended

2 ACTION AREA

The Yazoo Study Area (Figure 1), herein the "Action Area," includes the entire project footprint and all areas that may be directly (pump construction) or indirectly (changes in hydrology) affected by the various federal actions described above and not merely the immediate area involved in the action (50 CFR 402.02).

2.1 The Yazoo Study Action Area

The Action Area is located in west-central Mississippi immediately north of Vicksburg, Mississippi, and includes all or portions of Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo counties, Mississippi and part of Madison Parish, Louisiana. The triangular shaped area, also referred to as the Yazoo Backwater Area (Figure 2), extends northward about 65 miles to the latitude of Hollandale and Belzoni, Mississippi, and comprises about 1,446 square miles.

The Action Area is bordered by the left descending bank of the mainline Mississippi River levee on the west, the west bank levees of the Whittington Auxiliary Channel and the Yazoo River on the east, and the Yazoo Backwater Levee on the south. Big Sunflower and Little Sunflower rivers, Deer Creek, and Steele Bayou flow through the Action Area. The Action Area contains approximately 926,000 acres of which approximately 500,000 acres are lands within the 100-year flood frequency (Figure 2). The area historically has been subject to flooding from backwater by the Mississippi River and headwater flooding from the Yazoo River, Sunflower River, and Steele Bayou.

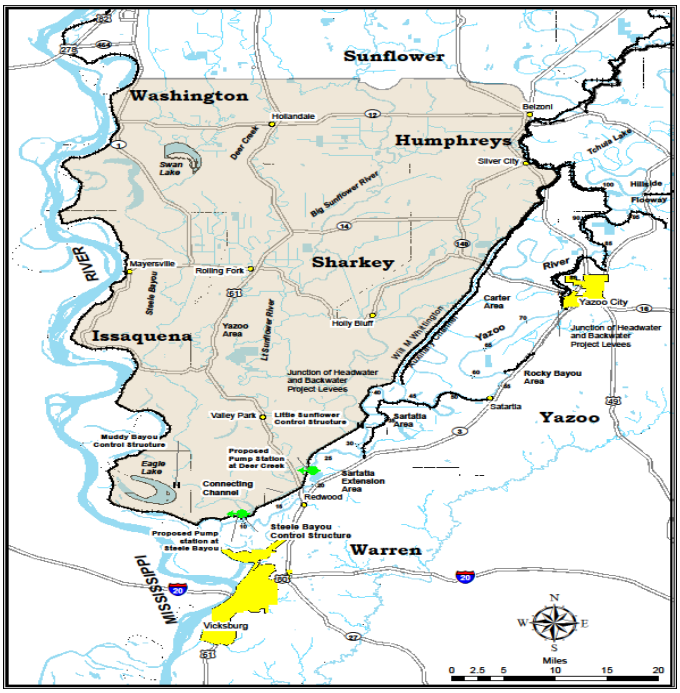

Figure 1. The Yazoo Study Area (tan shading) includes Issaquena, Humphreys, and Sharkey Counties, and parts of Washington, Sunflower, and Warren Counties, in west-central Mississippi.

Figure 2. The Yazoo Backwater Area, as defined in the USACE (2020) Supplemental Environmental Impact Statement for the Yazoo Study Area, Mississippi.

3 PROJECT DESCRIPTION

3.1 Proposed Plan

The Proposed Plan represents a balanced approach to addressing the flood damage reduction and environmental opportunities in the Yazoo Action Area. The Plan includes both structural and nonstructural measures, including a 14,000 cubic-foot-per-second (cfs) pump with a year-round pump, and conservation easements and reestablishment of forest on approximately 2,700 acres of open/agricultural land within the 1 to 2-year flood frequency elevation.

3.1.1 Pump Station/Inlet Channel/Outlet Channel/Access Road/Utilities. The 14,000 cfs pump station (Figure 3), located near Deer Creek, would consist of twelve pumps, with year-round pump-on activation at water stage elevation 87.0 feet (approximately 1-year frequency), National Geodetic Vertical Datum (NGVD), when the riverside water elevation is greater than the landside water elevation at the Steele Bayou water control structure. Current operation of the Steele Bayou water control structure within the Yazoo Study Area will remain the same, maintaining the water levels in the Action Area between 68.5 and 70.0 feet, NGVD, during low flow periods.

The pump station will be located in Warren County, Mississippi, approximately eight miles northeast of the Steele Bayou water control structure near Deer Creek, between the Yazoo Backwater levee and the Yazoo River, and approximately three miles northeast of the intersection of Highway 465 and Highway 61. The pump station right-of-way will be approximately 211.76 acres (Figure 4). Construction of the pump station, inlet channel, outlet channel, new levee associated with the pump station, along with removal of part of the existing levee for construction of the inlet channel and subsequent construction of a bridge over the inlet channel to connect the existing levee, will take place within the pump station right-of-way. Figure 3 shows a three dimensional model view of the completed pump station and associated features. Figure 4 shows the pump station, access road, and utilities right-of-ways.

The pump station will be constructed of reinforced concrete and will consist of wing walls, flood walls, retaining walls, intake structures, pump bay monoliths, a control room monolith, and a service bay monolith. Construction and permanent access to the new pump station will be accessed by traveling northeast on the existing Yazoo Backwater levee for approximately 2.3 miles from Highway 61. The existing Yazoo Backwater levee road will need to be widen to accommodate traffic, which will require the crown of the levee to be widened. The right-of-way for the access road and subsequent levee widening will be approximately 25.07 acres. The access road will enter the restricted facility by way of the new levee. The new levee and pump station are joined and tie into the existing backwater levee. The crown of the levees will be paved with asphalt to provide a smooth surface course. Utilities will be run parallel and approximately 80 feet to the southeast of the pump station access road. The utilities line right-of-way will be approximately 50 feet wide and approximately 10.54 acres. Utilities (both natural gas and electricity) are readily available and in close proximity to the pump station.

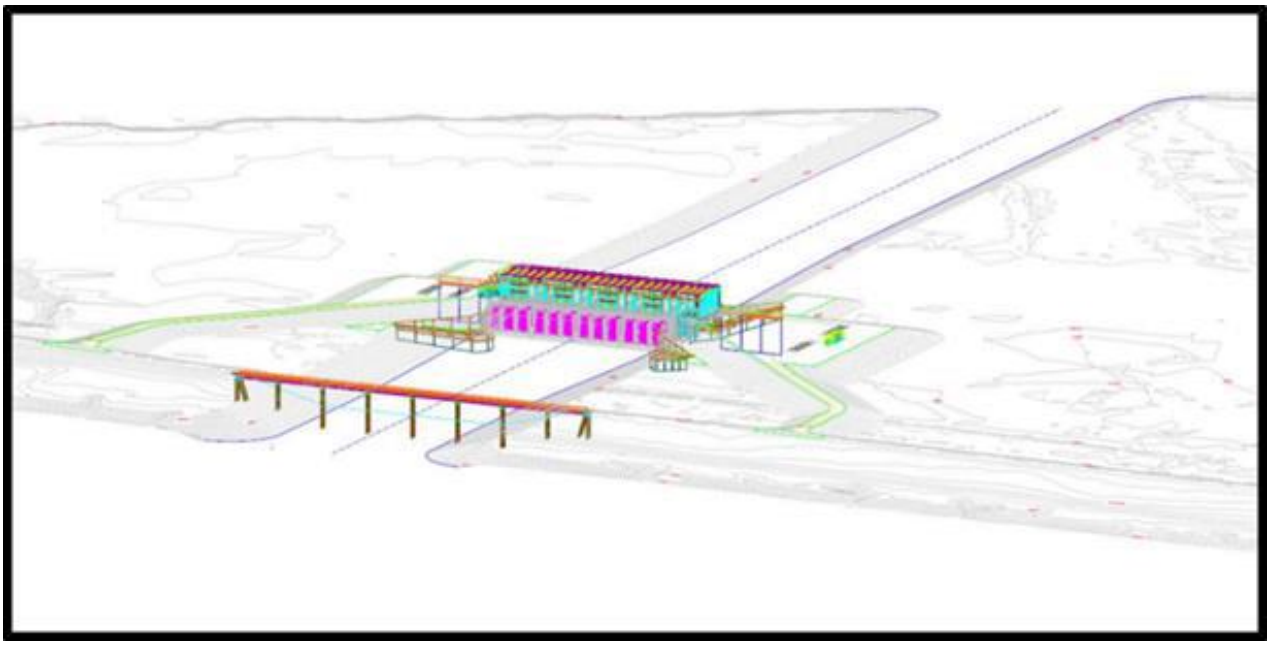

Figure 3. A 3-dimensional model view of the proposed 14,000 cfs pump station

Figure 4. Footprint for the proposed 14,000 cfs pump station, access road, and utilities rights-of-ways.

An inlet channel will be constructed to connect the pump station to the existing connecting channel. The inlet channel will be approximately 1,200 feet long and will require the excavation of approximately 500,000 cubic yards of material. The inlet channel will be lined with riprap and filter stone. An outlet channel will connect the pump station to the Yazoo River. The outlet channel will be approximately 1,800 feet long and will require the excavation of approximately 475,000 cubic yards of material. The outlet channel will be lined with riprap and filter stone. The inlet and outlet channel will form a secondary means of transferring floodwaters from the Yazoo Study Area into the Yazoo River via the pump station to reduce the damages resulting from Mississippi River backwater flooding.

Impervious material taken from the channel and structural excavation, if found suitable, will be used in construction of the new cofferdam and new levee and for structural backfill. If a shortage of impervious material from the channel and structural excavation occurs, borrow material will be hauled on-site from the borrow area location. The new levee will be constructed to finish grade elevation of 112 feet, NGVD, with 1 on 4 side slopes. A bridge will be constructed across the inlet channel to connect the existing Yazoo Backwater levee for continued public use, however access to the new pump station will be restricted. The new bridge will be pile founded and approximately 700 feet long. Construction will require the use of a cofferdam that will be at an elevation of 112 feet, NGVD, and will have 1 on 4 side slopes. The cofferdam will require approximately 105,000 cubic yards of borrow material for construction.

Construction will require a preload at the site which will have a crown elevation of 125 feet, NGVD, and a berm at elevation 107 feet, NGVD, which will be 690 feet wide and 450 feet long. The preload will be removed prior to construction and the cofferdam will be removed upon completion of construction. All excess and/or unused material removed for construction will be taken to a government approved disposal area or stockpiled for possible future use. All construction activities associated with constructing the new pump station will adhere to federal, state, and local laws.

2.3.2 Borrow Area. The borrow area is located north of Highway 465 and north of the Yazoo Backwater levee, approximately eight miles southwest of the pump station, and approximately 0.5 mile northwest of the Steele Bayou water control structure (Figure 5). The borrow area right-of-way is approximately 35.92 acres. An access road will be constructed to access the borrow area from Highway 465. From Highway 465, approximately 0.1 mile of site work will be required in order to construct an access road to tie into an existing coffer dam. The access road will be constructed on the coffer dam and continue for approximately 0.25 mile and intersect with the existing Yazoo Backwater levee road. The access road will then continue west along the Yazoo Backwater levee road for approximately 0.2 mile. From the Yazoo Backwater levee road, the access road construction will turn north for approximately 0.15 mile to the borrow area. The borrow area access road right-of-way is approximately 9.74 acres. If suitable, the material from the excavation of the inlet and outlet channels and corresponding cofferdam will be used to construct the new levee and cofferdam. If the excavated material is deemed unsuitable for construction, fill material and/or additional fill material will come from the borrow area. The borrow area will also be used as a disposal site for material deemed unsuitable from excavation at the pump station site.

Figure 5. Proposed borrow area and access road rights-of-ways for the 14,000 cfs pump station

4 SPECIES/HABITAT CONSIDERED IN THIS CONSULTATION

4.1 Species Potentially Impacted by the Project and Included in this BA

The following species may be affected by the proposed action:

- Pondberry (*Lindera melissifolia*) federally **Endangered**

These additional species (and associated ESA status) were excluded from the BA because they are being addressed separately and through informal consultation with the USFWS.

- Wood Stork (*Mycteria americana)* **Threatened**
- Northern Long-eared Bat (*Myotis septentrionalis)* **Threatened**
- Eastern Black Rail (*Laterallus jamaicensis)* **Threatened**
- Piping Plover (*Charadrius melodus)* **Threatened**
- Red Knot (*Calidris canutus)* **Threatened**
- Least Tern (*Sternula antillarum athalassos)* **Endangered**
- Pallid Sturgeon (*Scaphirhynchus albus)* **Endangered**
- Fat Pocketbook (*Potamilus capax)* **Endangered**
- Rabbitsfoot Mussel (*Theliderma cylindrical)* **Threatened**
- Sheepnose Mussel (*Plethobasus cyphyus)* **Endangered**

4.2 Critical Habitat

Critical habitat is defined in Section 3 of the Endangered Species Act as: (1) the specific areas within the geographic area occupied by a species, at the time it is listed in accordance with the act, on which are found those physical or biological features, (2) that are essential to the conservation of the species and that may require special management considerations or protection, and (3) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. The FWS has not proposed establishing pondberry critical habitat in either Mississippi or in other states in which the species is known to inhabit. Therefore, there is no critical habitat in the Action Area associated with pondberry.

4.3 Pondberry Status

Pondberry was federally listed as an endangered species on 31 July 1986 (Federal Register 51(47):27495-27500). A Recovery Plan (USFWS 1993) was completed and published in 1993. The most recent USFWS 5-Year Review (USFWS 2014) recommended "No Change is Needed" regarding its federal Endangered status. Populations are considered stable to declining, with "likely stable" populations in Alabama, Missouri, and North Carolina; declining populations in South Carolina (except for perhaps some recently discovered additional populations on State and Federal lands); unknown population status in Georgia; declining in Arkansas (clearing and

logging activities have extirpated five populations and reduced the size of four others); and declining in Mississippi (USFWS 2014).

4.4 Pondberry Description and Species Account

Pondberry is a low growing, deciduous shrub ranging in height from 1.5 to 6.5 feet. The plants commonly grow in clumps of numerous scattered stems, and spreads vegetatively by stolons. The older portions of the stems are dark green to almost black with numerous irregularly spaced, but prominent lenticels, which appear very similar to saplings of young sassafras (*Sassafras albidum*) stems. The leaves are drooping and have a distinct and unique "lemony" sassafras-like odor when crushed (Buchanan and Finnegan 2010). Leaves are 0.75 to 2.5 inches wide and 2 to 6.5 inches long with a round to cordate base. The leaf veins are prominent and the undersurface of the leaf is hairy. Pondberry is distinguished from the two other North American members of the genus (*Lindera benzoin* and *Lindera subcoriacea*) by its drooping foliage, obtuse or rounded leaf base, conspicuous venation and the two lowest pairs of lateral nerves are not parallel to the ones above.

Pondberry is dioecious with male and female flowers found on separate plants; flowers of both sexes are pale yellow and small. The flower stalks and buds are often hairy. The plant flowers in the second to fourth year of growth. The fruit is about 0.5 inch long at maturity, elliptical, and turns bright scarlet red at maturity in the fall. The flowers develop in spring before leaves emerge (generally in early March) with mature fruit evident by October. Fruit stalks are often present until next year's flowering (USFWS 1990; Klomps 1980a; Tucker 1984).

Pondberry can form short-term persistent soil seed banks for 1-2 years (Connor *et al*. 2006, 2012; Hawkins *et al*. 2011) and some seeds may remain viable for longer periods in the soil seed bank (e.g., Smith 2003). Seed depredation may explain the lack of observed seedlings (e.g., Tucker 1984; Wright 1989; Devall *et al*. 2001; Aleric and Kirkman 2005b; Connor *et al*. 2006) and seeds on the soil surface with intact pulp presumably are sometimes removed by both birds and mammals (Aleric and Kirkman (2005b). Smith et al. (2004) documented both seed predation (Northern Cardinal [*Cardinalis cardinalis*]) and short-distance seed dispersal (Hermit Thrush [*Catharus guttatus*]) at five fruiting colonies in the DNF, but concluded that pondberry dispersal by birds that creates new colonies is unlikely. Northern Cardinal (*Cardinalis cardinalis*), Brown Thrasher (*Toxostoma rufum*), Swamp Rabbit (*Sylvilagus aquaticus*), Nine-banded Armadillo (*Dasypus novemcintus*), and Gray Squirrel (*Sciurus carolinensis*) (Abilio *et al*. 2008; Leininger *et al*. 2009) all were initially identified as potential pondberry seed or seedling predators. Subsequently, Martins et al. (2015) significantly expanded the list of avian and mammalian seed and seedling predators using videography.

The most comprehensive reviews on the life-history and habitat of pondberry are included in the pondberry recovery plan (USFWS 1993), the USFWS's (2007) Biological Opinion for the prior Yazoo Backwater Area Reformulation project, Devall (2013), and the USFWS 5-Year Review (USFWS 2014) for pondberry.

4.5 Taxonomic Status

Pondberry is a member of the family Lauracea. It is one of three members of the genus *Lindera* found in the southeastern United States, which also include *L. benzoin* and *L. subcoriacea*, a new species described by Wafford in 1983. Pondberry was first described as a new species by Tomas

Walter in 1788 (Tucker, 1984). The material upon which he based this description was collected from what is present-day Berkeley County, South Carolina (Mercer 1984). The USFWS (2014) reviewed the taxonomy of *Lindera melissifolia* for both the listing document (51 FR 27495) and recovery plan (USFWS 1993), and is currently recognized as an accepted taxon by the Integrated Taxonomic Information System (2012) and Flora of North America (van der Werff 1997).

4.6 Pondberry Range and Population Level

Pondberry occurs in the Mississippi River alluvial plains of Missouri, Arkansas, and Mississippi, and the Coastal Plains region of Alabama, Georgia, South Carolina, and North Carolina (Figure 7). In the early 2000's approximately 262 colonies/populations/sites of pondberry were known to exist across its seven-state range, including approximately 194 colonies in Mississippi, primarily in DNF (182 colonies in DNF and 12 colonies on private lands approximately 65 miles north of DNF); two colonies in Alabama; 36 colonies in Arkansas; eight populations in Georgia; 15 colonies in South Carolina; two populations in North Carolina; and five colonies composing one natural population in Missouri. The USFWS (2014) 5-Year Review of pondberry provided the most recent range-wide evaluation of population sizes/estimates for pondberry. At that time, there were 61 extant natural pondberry populations (see USFWS 2014 for definition of "population[1]") in Alabama (1), Arkansas/Missouri (17), Georgia (13), Mississippi (16), North Carolina (2), and South Carolina (12) (Figure 6). Pondberry historically has been reported from Louisiana and western Florida, however populations in these states are considered extirpated (Tucker 1984, Wofford 1983, USFWS 1990). Since the 2014 5-Year Review by USFWS, populations undoubtedly have been discovered or extirpated, but to our knowledge, this information recently has not been collated into a single range-wide evaluation (but perhaps will be in the next USFWS 5-Year Review).

At the time of the USFWS 5-Year Review (2014), Mississippi had 16 extant pondberry populations with an estimated minimum 44,000 stems/plants (also see USFWS 2007). All colonies within these populations were found in bottomland hardwood forests within the Mississippi Alluvial Plain. The USFS has conducted extensive searches within the DNF in Sharkey County, and these DNF plants/colonies account for 13 of the state's pondberry populations with an estimated minimum of 35,000 stems/plants (USFWS 2007, USFWS 2014). Despite USFS best management practices to avoid adverse ground-disturbing activities to these plants/colonies during forest management (Banker and Goetz 1989; Bowker 1989, *in litt*.), some pondberry colonies have either been extirpated or have experienced declines, potentially related to stem dieback, laurel wilt disease, changes in hydrology, interspecific plant competition, and natural canopy disturbances (Gulf South Research Corporation 2005, USFWS 2007, USFWS 2014). Other populations in Mississippi have been known to occur in Bolivar (two pondberry populations on private lands with as many as 20,000 and 5,000 stems/plants) and Sunflower Counties (private lands population of approximately 1,500 stems/plants). Leonard (2010) conducted searches in Panther Swamp National Wildlife Refuge in Yazoo County but found no pondberry during 2006 and 2007. Additional monitoring is needed to more adequately

[1] Devall et al. (2002) considered a pondberry population as a colony or colonies separated by at least 1 mile from other colonies, as an interim working definition, based on long-distance flights of ground dwelling bees that pollinate the species.

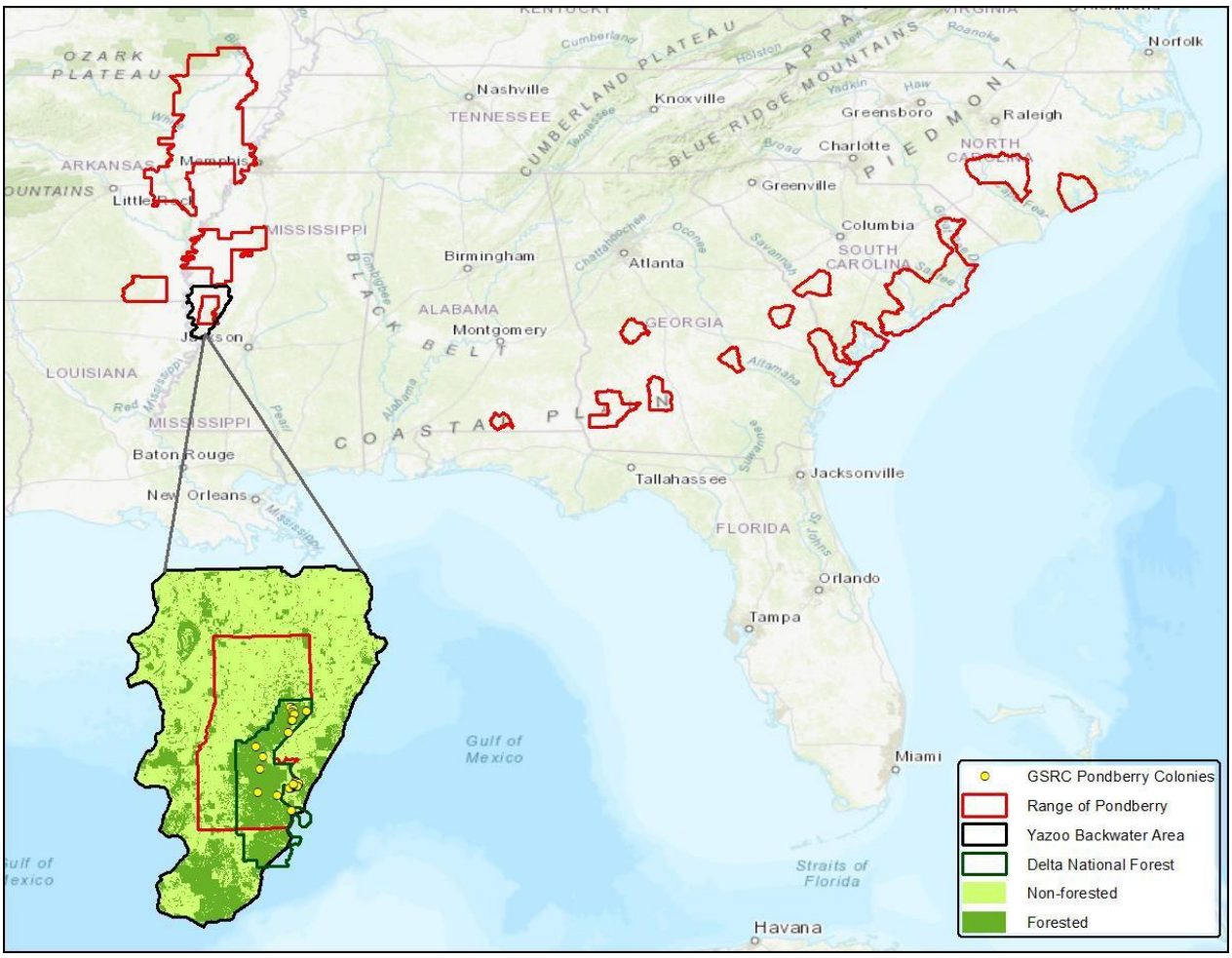

Figure 6. Pondberry Range (source: USFWS (2020)). Inset shows Delta National Forest, Mississippi with Gulf South Research Corporation (GSRC) Pondberry colony locations.

quantify and understand pondberry's current distribution and abundance, health, long-term colony and population dynamics, effects of forest management, and persistence.

4.7 Pondberry Life History

Pondberry populations are generally found in bottomland hardwoods under a partially shaded canopy of mature forest (Klomps 1980a, Tucker 1984). Colonies in Mississippi occur in small dense clumps usually averaging less than 0.10 acre in size. Numerous field investigations indicate that vigorous healthy colonies were found in homogeneous clumps with shrub associates growing adjacent to, but not within, the clumps. In less vigorous colonies, shrub/vine associates were usually growing within the clumps.

Individual stems within each colony are short-lived, generally dying by their seventh or eighth year. Young stems sprout from the rootstock and replace the dying stems. Over time, colonies

may expand vegetatively, resulting in many vastly rooted stems. Thus, a typical vigorous colony is composed of numerous relatively tall stems, dead and dying stems, as well as young leaf sprouts. Despite numerous studies attempting to identify seed dispersal agents, there is little information regarding new seedling establishment and growth; therefore, colony expansion is suspected to be almost exclusively vegetative (Tucker 1984, FWS 1990).

Individual stems of pondberry begin flowering by their second to fourth year of growth (Tucker, 1984). Flowering begins in late February to early March in Mississippi and generally lasts no longer than 2 weeks. Pondberry is dioecious (male and female flowers found on separate plants). A typical colony in Mississippi is composed primarily of male stems with few to several female stems. In some instances, the entire colony is composed of male plants. In general, seed production in relation to the total number of stems is low. Because flowering occurs in late February to early March, frost or near freezing temperatures often damage flowers, thereby reducing fruit production even more. Rayner and Ferral (1988), in a study of 73 colonies from the Honey Hill region of South Carolina, reported that only 22 percent of all colonies surveyed produced fruit, with fruit production averaging only 22 fruits per colony. They also noted that fruit production did not seem to improve with plant health since sexual reproduction appeared to be poor even in large healthy plants.

Few details are known about pondberry's reproduction. Pondberry is suspected to be insect pollinated. Tucker (1984) noted small bees and flies on flowers in Arkansas. The fruit contains many oils and similar compounds, which are suspected to make the fruit unpalatable to most wildlife. Therefore, seed dispersal is likely accomplished by seeds merely falling to the ground or by animals (such as birds) picking the fruit and depositing elsewhere (USFWS 1990). No plant species currently are known to hybridize with pondberry.

4.8 Pondberry Habitat Requirements

Habitat requirements of pondberry appear to be variable across its range. Pondberry is found within seasonally flooded wetlands that broadly include riverine bottomland hardwood forests and geographically isolated wetlands (i.e., Carolina bays, limestone or lime sink ponds, sand ponds, and lowland sand prairie depressions) in the Atlantic and Gulf Coastal Plains and Mississippi Alluvial Valley of the southeastern United States (USFWS 2014). In general, pondberry occupies wetland habitats that are normally flooded or saturated during the dormant season, but infrequently flooded during the growing season for extended periods (Tucker, 1984).

Hydrology at geographically isolated wetlands typically is maintained by precipitation, and in some cases, groundwater. Hydrology for pondberry colonies in bottomland hardwoods is maintained by overbank flooding, local precipitation, storage in depressions or at sites with soils that impede drainage independent of overbank flooding, or a combination of the previous two factors (USFWS 2014).

Tucker (1984) reported that pondberry populations in Mississippi are associated with “mature bottomland hardwood forests in low depressions.” The USACE (1991) reported that pondberry colonies in Mississippi are typically found on slight ridges in a ridge and swale community which is either frequently or periodically flooded or is in proximity to a permanent water body.

The extant populations in Mississippi are all associated with bottomland hardwoods at elevations where rainfall/local hydrology dominates the hydrologic conditions at the pondberry colony site.

Hawkins et al. (2009) provided a quantitative description of bottomland hardwood forests in the DNF that supported pondberry colonies. They analyzed extensive data and found that canopy and subcanopy trees were similar among sites, colonies were not associated with mean tree density or dbh, and forest composition and structure are a reflection of hydrologic regime, topography, historical disturbance, and absence of any recent disturbance.

The Mississippi populations were thought to occur on soils characterized by the Sharkey-Alligator-Dowling Association and less frequently on soils characterized as Alligator-Dowling-Forestdale Association as delineated by the Natural Resources Conservation Service soil survey maps of Sharkey County, Mississippi. These soil associations are very similar, with both being found on level, poorly drained soils in slack-water areas and depressions. The soils within these associations all have poor drainage, high water table, low permeability rates, and gleyed B and C horizons (Tucker 1984, Banker and Goetz 1989). The tight clay subsoils of these associations result in slow permeability rates (0.2 to 0.6 inch per hour near surface and 0.06 inch per hour in subsoils). Therefore, overland sheet flow dominates water movement in these soils (Banker and Goetz, 1989).

The USACE (1991) reported that of 44 pondberry colonies surveyed, 41 percent were located in surface soils classified as silty clay, 32 percent is silty clay loams, and 21 percent in silt loam soils. In addition, 62 pondberry sites surveyed in 2000 and 2005 (Attachments 3 and 6) contained clay loams or silty clay soils (Gulf South Research Corporation [GSRC] 2000, 2005). This indicates that pondberry colonies will not likely be found on strictly heavy Alligator, Sharkey, or Dowling clay soils.

4.9 Associated Species

Hawkins et al. (2009b) investigated the canopy and subcanopy composition of bottomland forests associated with pondberry populations in Mississippi, Arkansas, and Missouri, and found pondberry distribution was not associated with mean tree density or dbh, and no single indicator tree species could be identified. Their data did suggested that pondberry tended to be more associated with flood tolerant than flood intolerant species. Hawkins *et al*. (2010) conducted focused studies in bottomland hardwood forests of Mississippi on the vascular plants associated with pondberry colonies, and found 69 species growing within 1 m of pondberry colonies in Bolivar and Sharkey Counties. Of these species, nine were identified as having weedy characteristics while eight species of vines (five *Smilax* spp. and three *Vitis* spp.) were identified that could strongly compete with pondberry for light.

Several early investigators from the 1980's studied tree species associated with Mississippi pondberry populations. Tree species most often associated with colonies included oaks *Quercus* spp.), Sugarberry (*Celtis laevigata)*, American Elm (*Ulmus americana)*, Green Ash (*Fraxinus pennsylvania*), and hickories (*Carya* spp.) (Morgan 1983, Tucker 1984). From the early 1990's to 2005, various investigators including USACE and GSRC continued to collect data on associated tree and shrub species, more clearly defining associates (GSRC 2000, 2005). The most common overstory tree species were oaks (*Q. phellos, Q. nuttallii, and Q. lyrata*), sweetgum (*Liquidambar styraciflua*), and elms (*U. crassifolia, U. americana, and U. alata*). In 2005, the most common overstory species were Sweetgum, Overcup Oak, and Pecan. Devall, et al. (2001), recorded the dominant trees inhabiting the 40-acre Red Gum Research Natural Area in Sharkey County. Dominant tree species observed included Sweetgum, Box Elder (*Acer negundo*), American Elm, and Sugarberry. Nordman (2002) conducted a botanical inventory of a

164x65-foot plot containing pondberry in Compartment 7 of DNF in 2002 and characterized the pondberry colony as an “Old growth sweetgum stand with canopy gaps containing Cedar Elm (*U. crassifolia*) trees up to 20-inch dbh in the subcanopy, with a slightly higher topography than most pondberry sites in DNF.”

4.10 Other Pondberry Research

In 2005, the U.S. Army Engineer District, Vicksburg (MVK) provided funding to the U.S. Department of Agriculture, U.S. Forest Service (USFS), Southern Research Station, to conduct extensive pondberry research investigations. The MVK entered into a $5 million, 6-year cooperative agreement with USFS to conduct experiments on pondberry that resulted in a multitude of reports and publications in the following areas-- the role of flooding and sunlight (e.g., Lockhart et al. 2006, Lockhart et al. 2015); silvicultural treatments (e.g., Lockhart 2016), impact of periodic flooding on competition; dynamics of native pondberry colonies; and stem dieback, population genetics (Echt et al. 2011), and seed ecology. This program also involved the propagation of over 80,000 pondberry plants to conduct genetic testing, pathogen and predation analyses, and flood regime requirements. The latter included both laboratory and field experiments involving 12 1-acre ponds (impoundment cells). Some of the resulting publications were included in the 2007 Final Yazoo Backwater Area Reformulation Study EIS (i.e., Pondberry Regional Habitat Requirements; Pondberry Profile; Re-evaluation of Pondberry (*Lindera melissifolia*) in the Big Sunflower River and Yazoo River Backwater Areas; Pondberry Biological Assessment; and Pondberry Final Biological Opinion), while others have been published subsequently in the peer-reviewed literature and summarized below.

4.11 Threats and Reasons for Decline

While there are no records in the literature of pondberry's status (whether it was abundant or scarce) before modern times, apparent reasons for the species current endangered status are discussed below; and land clearing operations for agricultural, commercial, and private development (USFWS 1990). Timber harvesting activities (and especially those that include use of heavy equipment) can crush plants, fell trees into pondberry colonies, uproot trees near colonies, unfavorably modify forest canopy, and possibly change local hydrology. Kral (1983) reported that single-tree selection harvesting in hardwoods would likely not affect pondberry, while clear-cut harvesting, which would result in increased surface water runoff, could potentially increase floodwater levels to a detrimental degree. Within the DNF in Mississippi, the USFS, along with USFWS, determined that a 100-foot undisturbed buffer around known pondberry colonies along with a 40-acre size limit on clear-cut openings would prevent any major changes in hydrology and maintain an adequate crown closure around a colony (Banker and Goetz, 1989).

Several investigators have made general statements about drainage activities and subsequent effects on pondberry such as ditching which, could alter the surface and/or ground-water regime in a manner that could reduce the plant's vigor or possibly eliminate it from an existing site (Kral 1983, Wright 1989, USFWS 1990). The USACE, through extensive field studies of pondberry within Mississippi and consultation with various experts, determined that only drainage activities that significantly alter the local hydrologic regime of depressions, ponds, sinks, or other areas governed by localized hydrology would adversely affect pondberry colonies.

A third factor associated with the loss of habitat is land clearing due to agricultural interests and other developments. Throughout the pondberry range, bottomland hardwoods and similar habitat types have been extensively cleared. These wetlands provide a variety of functions (e.g., water storage; floral and faunal habitat) and values (e.g., flood risk reduction; recreation) within the Mississippi River Valley (Smith and Klimas 2002). However, historic landscape alteration has resulted in significant (>70 percent) declines in forested wetland acreage, and associated losses of wetland functional capacities in the region (King et al., 2006).

4.11.2 Disease/predation. The literature indicates that nearly all colonies of pondberry are affected by stem dieback. Rayner and Ferral (1988) reported that stem dieback and predation were two factors that lead to poor colony health in the Honey Hill region of South Carolina. Stem dieback has been hypothesized to be fungal and/or drought related, but could be characteristic of the species. Predation has been observed by deer and insects, mainly the spicebush swallowtail caterpillar (Rayner and Ferral, 1988; USACE, 1991). Devall et al. (2000), found six insect species in association with pondberry, but none of them appear to be a limiting factor for the plant.

Through field studies of pondberry colonies in Mississippi, stem dieback and insect damage seem to influence the general health of many colonies (USACE 1991; GSRC 2000, 2005). Devall et al. (2000), reported dieback of 33 percent of the stems during June at a site in Shelby County, Mississippi. The best available information suggests that stem dieback is related to fungal pathogens, drought, and the interactions between pathogens and drought. In addition, Devall et al. (2000), noted that in unusual conditions, stem dieback may be caused by winter freezing. Monitoring and studies of plant growth and decline at colonies in DNF indicated most instances of stem dieback were accompanied by abnormal patterns of sudden leaf wilt and death during the growing season on plants of all size classes. This pattern was not indicative of senescence and dieback of old or large plants. Dead stems have been reported at various locations in different pondberry locations (e.g. GSRC 2000, 2005).

Wright (1989) first reported leaf senescence, summer leaf fall (facultatively deciduous), and twig dieback on pondberry plants in response to summer drought conditions in Arkansas. In DNF, the pathological symptoms of active dieback were directly observed and monitored by McDearman at 10 pondberry colonies (USFWS 2000b). The first symptoms were characterized by rapid leafwilt and sudden death of leaves and stems during a late summer dry period, without leaf abscission. Stem, branch (more than one stem), or whole plant death followed during the subsequent fall and winter. Since leaves died rapidly in the summer without abscission at DNF sites, additional investigations by Dr. Douglass Boyette (USDA Agricultural Research Service) revealed several potential pathogens, including *Diaporthe* sp., the cause of stem-canker.

Browsing by vertebrates appears to occur only occasionally. Some stems were reported to have been eaten by rabbits during the winter (Wright, 1989). The USACE (1991) reported evidence of herbivory at only one of 44 pondberry colonies in DNF.

Pondberry also is susceptible to a fungal pathogen (*Raffaelea lauricola*) that causes laurel wilt, which is a lethal disease for the species. Several researchers have investigated the impacts of this pathogen on pondberry (e.g., Best and Fraedrich 2018, Fraedrich et al. 2011).

4.11.3 Lack of reproduction. Most recent accounts and studies of pondberry list poor sexual reproductive success as another important reason in the decline of pondberry colonies. Many of the colonies studied in Mississippi consisted mainly of male plants. Some entire colonies contained only male stems. Consequently, colony expansion is suspected to occur primarily vegetatively. Sexual reproduction can be accomplished in a controlled environment (such as a nursery) as reported by FWS (1990), which indicated successful seed germination when seeds were depressed below the soil surface. During recent field surveys of the Mississippi population on DNF, numerous apparently viable seeds were observed on plants although no germination from the previous year's fruits were observed. With the abundance of suitable habitat within DNF, it is likely that if germination and sexual reproduction can occur in the wild, it could be occurring here. However, reports by Tucker (1984) and Morgan (1983) indicated that germination and new seedling establishment may not occur in the wild.

4.11.4 Competition. Hawkins et al. (2010) investigated three disjunct pondberry populations in Mississippi over three years and found that most associated species do not appear to have direct competitive impacts on pondberry, except for those that are invasive, become weedy, or have vining growth forms. For the latter, *Smilax* spp. And *Vitis* spp. have the greatest potential as strong competitors to pondberry.

5 Environmental Baseline

The purpose of this section is to describe the current condition and local terrestrial environment of listed species within the Action Area. The Yazoo Action Area lies in the alluvial valley of the Mississippi River. The topography is characterized by relatively flat, poorly drained land with slopes of 0.3 to 0.9 foot per mile. Elevations range from 120.0 to 75.0 feet, NGVD, from north to south.

5.1 Land Use

The Action Area is comprised primarily of woody wetlands (bottomland hardwood forests) interspersed with agricultural fields (Figure 7).

5.2 Hydrology

The hydrology of the study area is affected by both internal and external sources. Both sources have been altered by features of the Mississippi River and Tributaries Project. The frequency and duration of flooding due to the Mississippi River have been reduced by the mainline levees and the channel cutoffs (external sources). The levees keep floodwaters of the Mississippi River out of the Yazoo Study Area. The channel cutoffs lowered Mississippi River stages which in turn reduced backwater flooding. The maximum reduction of backwater flooding due to the channel cutoffs occurred in the 1950s. Aggradation of the Mississippi River channel bed has eliminated most of this reduction. Reservoirs constructed in the hill area of the Yazoo Basin and channel improvements to the Yazoo River also had an effect on stages within the Yazoo Backwater Area. The Yazoo Backwater Study Area has also benefited from other flood damage reduction features of the MR&T project that have been completed inside the study area (internal sources). A more detailed description of the hydrologic setting is included in Appendix 6 of the SEIS (USACE 2020).

- Yazoo Backwater levee extending from the end of the east bank mainline Mississippi River levee to the downstream end of the west side of the Will M. Whittington Channel levee along the Yazoo River.
- Water control structures at Steele Bayou and the Little Sunflower River. These structures allow interior runoff to be released when the ponding area stages are higher than the river stages and prevent backwater flooding from the Mississippi and Yazoo Rivers when the river is higher than the ponding areas.
- A 200 foot bottom width connecting channel between the Big Sunflower and Little Sunflower Rivers and an enlarged Little Sunflower River channel between this connecting channel and the Little Sunflower drainage structure.
- A 200 foot bottom width connecting channel between the Little Sunflower River and Steele Bayou, which also intercepts Deer Creek flow.

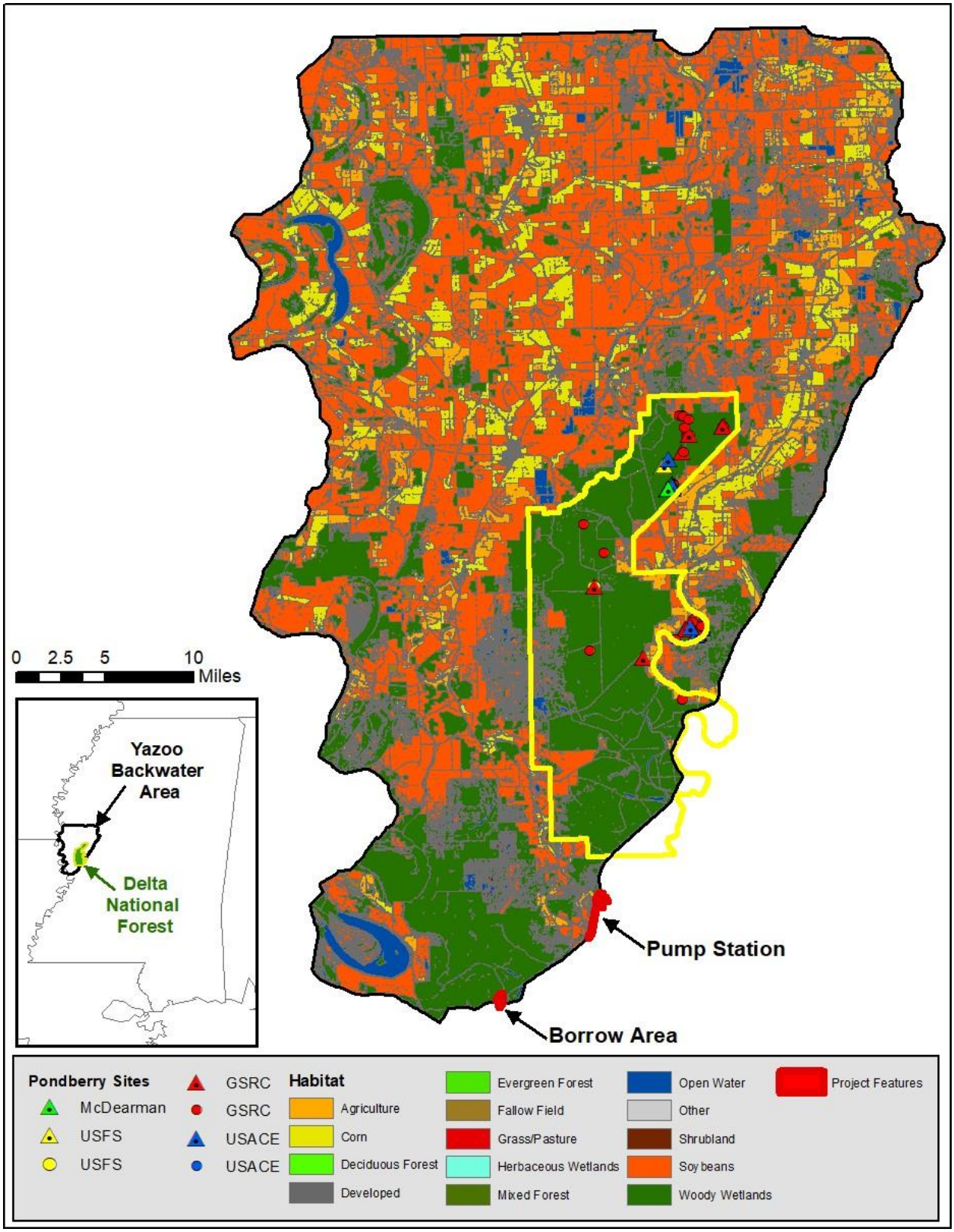

Figure 7. Land-use according the 2018 USDA NASS within the Yazoo Action Area

- A water control structure in Muddy Bayou which controls Eagle Lake inflows and outflows for environmental purposes.
- The inlet-outlet channel and the cofferdam around the pump station site.

The mainline Mississippi River levees are designed to protect the alluvial valley from the Project Design Flood (PDF) by confining floodflows within the leveed floodway, except where it enters the backwater areas or is diverted intentionally into the floodway areas. The mainline levee system is comprised of levees, floodwalls, and various control structures. When major floods occur and the carrying capacity of the Mississippi River leveed channel is threatened, additional conveyance through the Bird's Point-New Madrid Floodway, and relief outlets through the Atchafalaya Basin, Morganza, and Bonnet Carre Floodways are utilized as well as the storage capacity of flat lowlands at the confluences of tributaries with the Mississippi River. These tributary areas are commonly referred to as "backwater areas." These areas are protected from lesser floods by backwater levee systems that are designed to be overtopped near the crest of the PDF in order to reduce the peak flow of the PDF and allow safe passage within the mainline levee system. The system design which utilizes backwater storage at appropriate times in the PDF hydrograph has significantly reduced the need for even higher mainline levees. The Yazoo Backwater levees are designed to overtop by the PDF.

Ponding of runoff from the Big Sunflower River, Little Sunflower River, Deer Creek, and Steele Bayou is provided by two ponding areas connected by a 200 foot bottom width channel. The lower ponding area, formerly referred to as the Steele Bayou ponding area, lies in the lower end of the Steele Bayou Basin while the upper ponding area, formerly called the Sunflower River ponding area, is located in the lower portion of the Little Sunflower River Basin.

The interior area is protected from high stages of the Mississippi and Yazoo Rivers by levees; however, the area is subject to flooding resulting from inflow into the ponding areas from Steele Bayou, Deer Creek, and Big and Little Sunflower Rivers. Under present conditions, the flooding in the Yazoo Study Area primarily results from interior ponding behind the Yazoo Backwater levee when the Steele Bayou and Little Sunflower structures are closed due to high Mississippi River stages. The interior ponding areas consist primarily of agricultural and forested lands with several developed areas. Interior flooding begins at approximately 80.0 feet, NGVD.

During the rising and falling stages of a flood hydrograph, the water surface elevations in the upper ponding area are generally higher than the water surface elevations in the lower ponding area. This difference is due to slope through the connecting channel and head losses across bridges and overbank openings along Deer Creek ridge and the divide between the two areas. Near the peak of the flood event, there is little difference in water surface elevations between the two ponding areas.

The Muddy Bayou water control structure was constructed as a means of controlling inflows to and discharge from Eagle Lake during non-flood conditions in order to enhance the lake's water quality. However, due to the topography surrounding the lake, flood protection is provided as well.

During flood conditions, the Muddy Bayou structure is opened to allow water to pass from the lower ponding area into Eagle Lake only if it becomes apparent that this line of protection will be overtopped (about elevation 96.0 feet, NGVD).

Eagle Lake was formed from an abandoned Mississippi River channel. Although being cutoff from the Mississippi River by the Mississippi River levee, Eagle Lake provides numerous recreational benefits with numerous permanent and recreational homes located there. Without the two low-level levees (privately owned) in conjunction with the Muddy Bayou water control structure, the area would see significant backwater flooding.

The Steele Bayou water control structure is the principal drainage structure for the Yazoo Backwater Project. Any time the stage on the landside of the Steele Bayou and Little Sunflower water control structures is higher than the riverside and above 70.0 feet, NGVD, the gates are opened. With a rising river, the interior ponding areas are normally allowed to rise to an elevation of 75.0 feet, NGVD. The floodgates are closed when the river elevation is higher than the interior ponding levels. The Little Sunflower structure generally remains closed. It is opened during flood events when the riverside water surface elevation is less than the landside elevation and the Steele Bayou water control structure is closed.

The Steele Bayou water control structure is operated to control minimum water levels in the Steele Bayou and Little Sunflower ponding areas. The current operation plan calls for holding minimum water levels in the ponding areas between 68.5 feet, NGVD, and 70.0 feet, NGVD.

5.3 Terrestrial Habitat

Terrestrial resources within the 926,000 acre Yazoo Study Area are comprised of agricultural land or woody wetlands (i.e., primarily bottomland hardwoods). Bottomland hardwoods containing Cottonwood *(Populus deltoides),* Sycamore *(Platanus occidentalis),* and Black Willow (*Salix nigra),* Pecan (Carya spp.), Green Ash *(Fraxinus pennsylvanica),* Sugarberry *(Celtis laevigata),* Hackberry *(C. occidentalis),* Oaks *(Quercus* spp.), and Elm *(Ulmus* spp.) are the most valuable terrestrial habitat and are most likely to be impacted by the construction and operation of the Proposed Plan. Agricultural lands provide limited habitat for a small number of species.

5.4 History of Pondberry Surveys in the DNF

Pondberry has been one primary focus of the potential impacts of the Pump Project to native flora and fauna for more than two decades. In the 1990's and early 2000's, the USFS, USFWS (McDearman, Unpublished Data), Gulf South Biological (1991), Gulf South Research Corporation (GSRC; 2000, 2005), and others, completed a variety of pondberry surveys and site assessments in the Yazoo Basin across both the DNF and adjacent private and public lands, with a goal of documenting distribution and abundance, and to measure a variety of colony and associated forest and hydrologic metrics as a means to characterize optimal pondberry habitat in the Mississippi Alluvial Valley.

In the 1990's the USFS surveyed approximately 32% of the DNF (19,783) acres for pondberry. Also in the 1990's, the Corps surveyed all rights-of-ways for the Yazoo Backwater Project, 2,000 acres of bottomland hardwood forest with high potential for pondberry occurrence, and 3,600 acres associated with the Upper Steele Bayou Project. These efforts combined yielded a minimum of 182 pondberry colony sites within the DNF (USACE 2005b) (Figure 8).

In 2000, GSRC documented and georeferenced via global positioning system (GPS) 62 distinct pondberry colonies, including detailed metrics assessing general forest and colony characteristics (Gulf South Research Corporation 2001). Of those, 50 colonies were located in the DNF

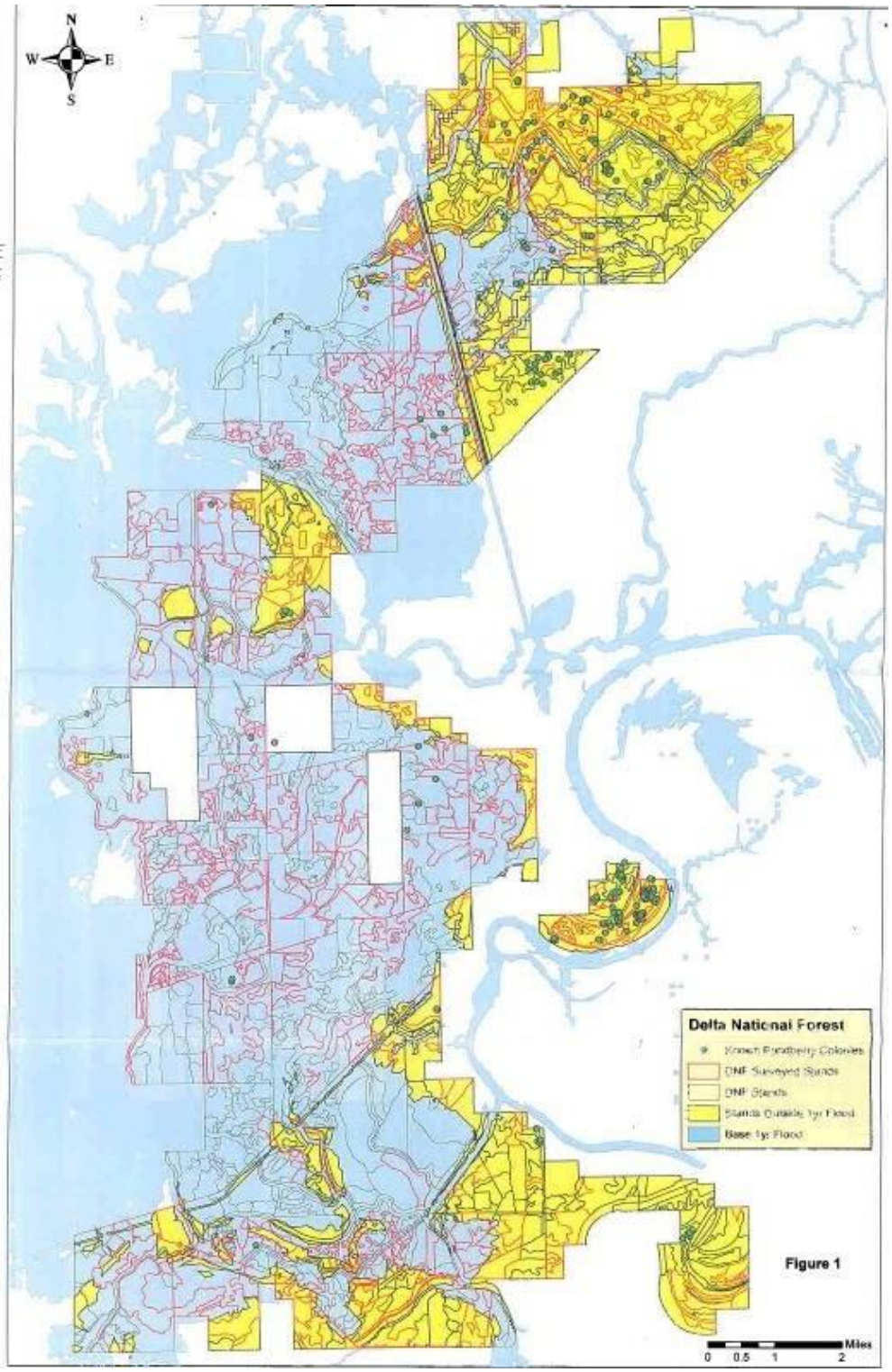

Figure 8. Pondberry colony sites as delineated by the U.S. Forest Service in the 1990's.

(primarily Sharkey County) and 12 were located on private lands in Bolivar and Sunflower Counties (Figure 9). In 2001, the USFWS contracted with Gulf South Biological Surveys, Inc. (2001) to investigate a subset of DNF colonies and their locations relative to hydrology associated with ponded depressions. During this work, Gulf South Biological also conducted stem counts at GSRC points 1-46 and 53-56 in the DNF (Table 1). In 2005, GSRC relocated 57 of the original 62 DNF colonies and again assessed site characteristics similar to those measured in 2000. The USACE ERDC compiled stem count data collected from 2000-2005 and summarized Table 1. Of those colonies in the DNF, mean number of stems per colony appeared to have declined from 2000 (n=240) to 2005 (n=147). Subsequently, no assessments of these same colonies has been completed to our knowledge until 2020.

During July 2020, the ERDC-EL revisited and assessed 50 of the DNF GSRC colony sites (GSCR 1-46, 53-56) within a 2-week timeframe (Figure 10). Pondberry was not found at any of the colony sites, but in the course of those surveys, 12 new colonies were identified and described. Subsequent to the July 2020 effort, the ERDC-EL determined that coordinates used for these surveys included a historical GIS projection error that resulted in all GSRC points being shifted 200m from their original location. In September 2020, the ERDC-EL again deployed with corrected GIS data and revisited the same 50 GSRC plots, along with the newly discovered ERDC-EL colonies, and historical colony sites provided by the USFWS (McDearman Sites). We also visited three sites provided by the USFS (Williamson et al. 2019) where pondberry was documented in 2019 within DNF Compartments 9 and 25.

5.4.1 Narrative on Accuracy of GSRC Plots

1. We received the initial Pondberry GIS shapefiles from MVK in spring 2020, which were converted to GPS coordinates and used by the ERDC field teams to navigate to the GSRC plots in July. No reports that we have in possession, to include GSRC reports, prior BA's or the 2007 BO, contain x,y coordinates for any pondberry colonies in the DNF. During the initial July 2020 assessment, we did not find pondberry at any of the GSRC plots. We completed a summary report for that effort and provided that to MVK and the USFWS Mississippi ES Office in August 2020.

2. On September 2, 2020, MVK provided ERDC with additional excel spreadsheets that included new pondberry coordinate information. After plotting these new data in GIS, and comparing with the initial shapefiles used for the July field efforts, we noted points were ~200 m displaced. We suspect this is a GIS projection error that occurred during a prior conversion sometime between 2005 and 2020.

   In addition, some of the data in the September 2020 excel spreadsheet had obvious errors (e.g. point fell outside of country, and these included GSRC 45 and GSRC 46). We had no way to correct these errors and know with certainty the actual colony x,y coordinates. Thus, to help rectify these errors, we consulted GSRC (2001), Figures 2 and 3, and made our "best guess" at coordinates based on the GSRC map for these few points. This resulted in a final set of coordinates for the September 2020 second ERDC field effort.

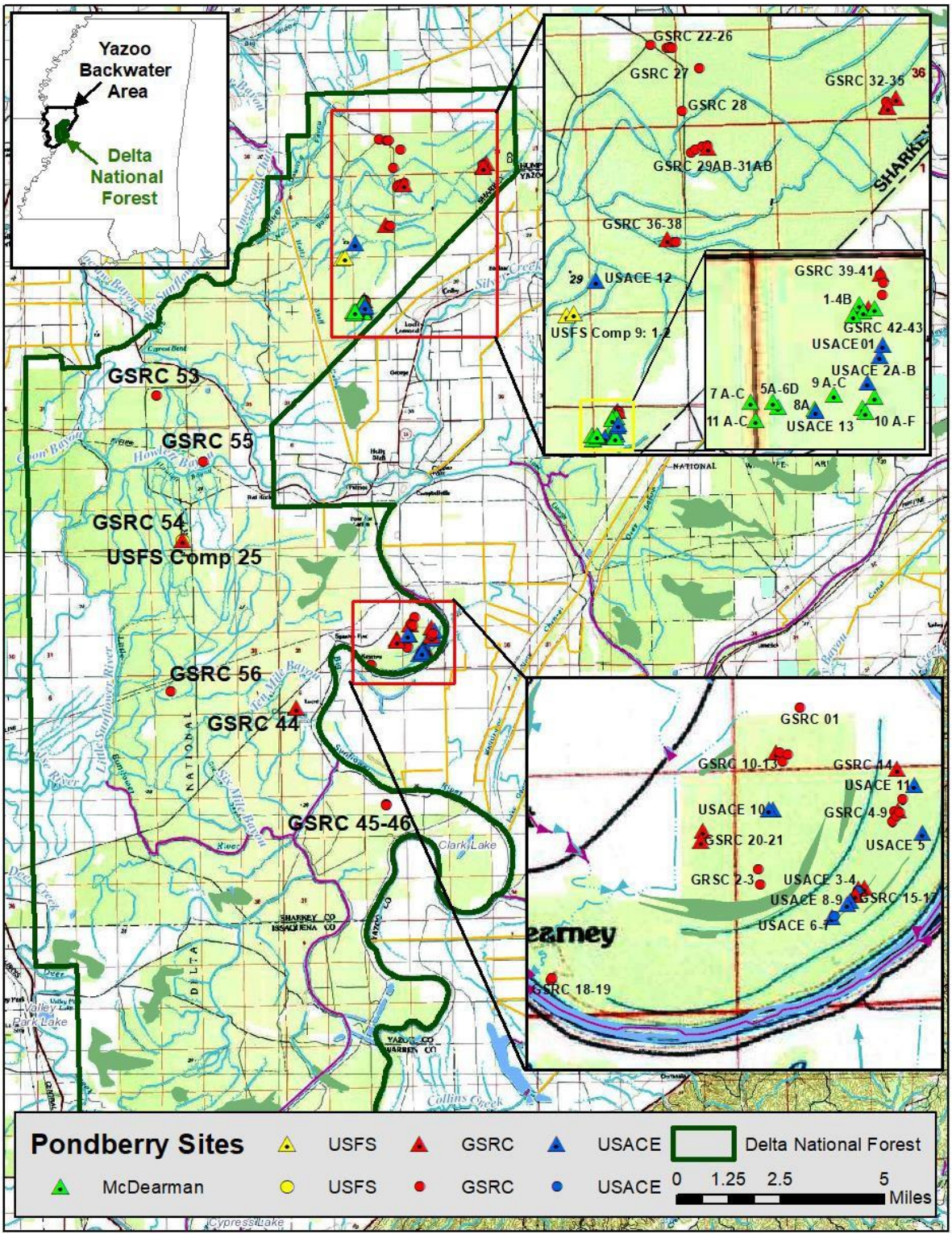

Figure 9. Extant (triangles) and extirpated (circles) pondberry colonies in the DNF, September 2020.

Table 1. Comparison of number of pondberry stems counted during colony surveys in the Delta National Forest, 2000-2020.

	Number of Pondberry Stems			
Colony ID	**GSRC 2000[1]**	**USFWS 2001[2]**	**GSRC 2005[3]**	**USACE 2020[4]**
GSRC 01	2	0	2	0
GSRC 02	36	22	14	0
GRSC 03	70	42	4	0
GSRC 04	142	60	-	3
GSRC 05	8	3	4	0
GSRC 06	10	4	3	0
GSRC 07	14	9	12	0
GSRC 08	6	5	3	0
GSRC 09	133	35+	-	0
GRSR 10	11	4	6	1
GSRC 11	37	29	19	0
GSRC 12	21	21	12	0
GSRC 13	6	1		0
GSRC 14	13	15	27	12
GSRC 15	143	50+	39	7
GSRC 16	40	25	40	7
GSRC 17	262	75	133	7
GSRC 18	424	Approx. 100	-	0
GSRC 19	20	15	-	0
GSRC 20	218	60	57	5
GSRC 21	72	37	45	3
GSRC 22	34	12	0	0
GSRC 23	3	3	0	0
GSRC 24	16	7	8	0
GSRC 25	2	2	13	0
GSRC 26	148	73	-	0
GSRC 27	15	12	-	0
GSRC 28	48	16	43	0
GSRC 29	485	More than 200	148	0
GSRC 30	300	More than 100	113	0
GSRC 31	1,800	150	565	9
GSRC 32	9	6	97	22
GSRC 33	22	27	16	0
GSRC 34	10	11	11	0
GSRC 35	25	24	63	24
GSRC 36	11	1000's	10	2
GSRC 37	161		43	0
GSRC 38	31		29	0
GSRC 39	12	"Few emergent stems at 39-41 to hundreds of stems at 42-43"	14	19
GSRC 40	5		-	0
GSRC 41	46		41	0
GSRC 42	2,064		719	59[6]
GSRC 43	3,791		1,274	319[6]

GSRC 44	72	25	40	3
GSRC 45	398	More than 200	401	0
GSRC 46	258	91	266	0
GSRC 47	125	DNS[5]	-	DNS
GSRC 48	115	DNS	-	DNS
GSRC 49	212	DNS	-	DNS
GSRC 50	-	DNS	-	DNS
GSRC 51	900	DNS	-	DNS
GSRC 52	219	DNS	-	DNS
GSRC 53	91	40	-	0
GSRC 54	47	150	558	87
GSRC 55	153	10	130	0
GSRC 56	94	300	1,280	0
GSRC 57	199	DNS	-	DNS
GSRC 58	177	DNS	-	DNS
GSRC 59	500	DNS	-	DNS
GSRC 60	37	DNS	-	DNS
GSRC 61	79	DNS	-	DNS
GSRC 62	250	DNS	-	DNS

Sources: [1]GSRC (2001); [2]Gulf Coast Biological Surveys, Inc. (2001); [3]GSRC (2005); [4]ERDC-EL (2020)
[5] Did Not Survey
[6] Plot falls inside of USFWS McDearman Plots 1-4 containing approximately 8,000 stems as estimated in September 2020

3. During the September 2020 ERDC field effort, we navigated to new coordinates and found PVC pipe colony markers at or in proximity to each GPS colony point, suggesting we were using accurate coordinates. We measured habitat metrics at GPS plot centers when Pondberry was not found, and at colony centroids when Pondberry was found.
4. On 3 November, 2020, USFWS provided ERDC with GIS shapefiles for 182 historical pondberry colonies in the DNF. We noted that GIS projections in the USFWS data set were in North American Datum (NAD) 27, thus converted to NAD-83 to ensure consistency with data collected in 2020. Appendix 3 provides a comparison of USFWS and ERDC-EL coordinates.
5. We determined the distance in meters between points provided by the USFWS to those used by ERDC-EL in the September 2020 surveys by conducting a spatial join based on location within GIS. For most plots, distances varied only slightly (i.e., 0.1-20 m); however, in some cases points were 50-100 m apart. Three sampling points were produced in error; GSRC plots 45 and 46 were approximately 1,200 m off from the correct coordinates which was subsequently discovered in a narrative in the first paragraph of Results in Gulf South Biological (2001). GSRC plot 8 is uncertain as comparing maps of plotted GSRC survey locations between the 2001 and 2005 report shows two different locations.
6. During July 2020, ERDC-EL discovered 12 new pondberry colonies. When GPS data were corrected, USACE-04 was noted as the same location as GSRC16, thus was eliminated as an ERDC-EL point. During September 2020, ERDC-EL discovered an additional four new colonies, for a total of 15 new ERDC-EL pondberry colonies at 13 different sites. We also noted some differences in stem counts between July and September 2020 ERDC-EL surveys (Table 2).
7. To date, we have been unable to find any data associated with historical DNF pondberry plots other than those visited by GSRC and Gulf South Biological between 2000 and 2005.
8. For consistency, we also noted dates when prior pondberry colony surveys, and associated forest and colony metrics, were recorded (Table 3).

Table 2. Comparison of stem counts at newly discovered pondberry colonies located in July and September, 2020, by ERDC-EL in the Delta National Forest, Mississippi.

Plot Name	X_COORD	Y_COORD	StemCount July	StemCount Sept	Comments
USACE01a	713314	3639829	1	22	
USACE01b	713327	3639866	-	65	newly discovered in September, approximately 25m from 01a
USACE02a	713273	3639740	1	4	
USACE02b	713276	3639745	1	-	
USACE03	715618	3626594	3	0	No pondberry found in subsequent September visit
USACE04	715630	3626603	11	7	This is actually GSRC16, but numbers reported here for comparison
USACE05	716065	3626985	37	42	
USACE06	715450	3626409	2	2	
USACE07	715462	3626417	1	0	No pondberry found in subsequent September visit
USACE08	715555	3626501	2	2	
USACE09	715573	3626523	10	16	
USACE 10	715028	3627126	2	-	
USACE10a	715018	3627142	-	1	
USACE10b	715046	3627142	-	7	28m from 10a (newly discovered in September)
USACE11	716008	3627310	1	1	

Table 3. Survey dates for pondberry assessments, 2000-2020, Delta National Forest, Mississippi	
Survey	**Dates**
GSRC 2000	11 May to 20 June, 2000
Gulf South Biological, Inc.	3-18 April, 2001
GSRC 2005	7 June to 13 July, 2005
ERDC-EL[1]	6-17 July, 2020
ERDC-EL[2]	12-22 September, 2020
[1] Initial sampling effort conducted just after floodwaters receded. Point locations were erroneous [2] The resampling effort occurred during September to provide ample time for regrowth following extensive flood inundation.	

5.4.1 Yazoo Backwater Reformulation Project (1994). During the period September-October 1994, field surveys for pondberry were conducted for the Yazoo Backwater Reformulation Project. The surveys included the entire direct rights-of-way for the project and a 5 percent survey (2,000 acres) of forested tracts, with a high potential for pondberry occurrence, south and west of the DNF. In addition to pondberry profile report information, flood frequency data and professional judgment were utilized to select forested tracts to survey. Also, the Mississippi Natural Heritage Program (MNHP) was asked to review its records for reported pondberry colonies within the Yazoo Backwater Project Area. In 2005, the USACE also updated its comprehensive Geographic Information System (GIS) database of known pondberry sites on DNF. This database includes 182 sites and was compiled from several sources, including compartment maps provided by DNF.

No pondberry colonies or evidence of pondberry presence was noted within either the rights-of-way or the 2,000 acres surveyed in 1994. In a 31 January 2000 letter with an accompanying site map, MNHP noted only 22 sites where pondberry colonies occurred within the proposed project area. None of the MNHP sites were located in areas of direct impact.

5.4.2 Survey Report – Reevaluation of Pondberry in Mississippi (2000). In May-June 2000, GSRC collected data from 62 colonies. Fifty colonies were in DNF, and 12 colonies were in Bolivar and Sunflower Counties, Mississippi. A range of data was collected on pondberry colony characteristics, surrounding stand characteristics, and site characteristics and elevation.

The purpose of this study was to update the 1991 pondberry profile and collect data on additional locations discovered since MVK conducted pondberry surveys in the early 1990s. The study area for this project included the DNF in Sharkey County, Mississippi; several parcels of private land in Bolivar County; and a 32-acre plot south of the DNF. Data were collected on 62 colonies (50 in DNF and 12 on private land). Data collected included physical characteristics of the colony, colony health, forest stand conditions, soil characteristics, and evidence of localized depressions. Importantly, the elevation of each colony and surrounding area was determined using a

professional land survey crew. These elevations were used to establish the flood frequency of the site. The flood frequency of the sites was used to analyze relationships among pondberry colony characteristics and flood frequency.

The analysis found that common associate species were similar to previous studies on the Mississippi pondberry populations. Common associate tree species were sweetgum, oaks, and elms, while associate shrub species were sugarberry, swamp dogwood, and deciduous holly. The study concluded there was no correlation between colony health, measured by stem density, stem diameter, stem height, and elevation (used to determine flood frequency of the site). In other words, there appeared to be no relationship between the variation in pondberry characteristics and variation in flood frequency (as determined from surveyed elevations of each pondberry colony). There was also no correlation between stem density and percent canopy cover or diameter at breast height. Therefore, it was difficult to predict where pondberry might be successful by using these quantifiable variables. Instead, evidence from this and the 1991 pondberry profile suggests that, in general, pondberry was successful in areas of high percent canopy cover, in a ridge and swale community, and in areas that are mostly affected by local precipitation and hydrology. The analysis documented that 94 percent of the colonies had evidence of localized depressions (defined as an area greater than 10 square feet that is slightly lower than the surrounding area and contains ponded water or evidence of ponded water (e.g., water-stained leaves) at some time).

5.4.3 Hydrology and Habitat Evaluation of 51 Selected Colonies of Pondberry in DNF, Mississippi (2001). In April 2001, FWS contracted Gulf Coast Biological Surveys, Inc., to examine selected sites of pondberry in DNF and to determine if these colonies were located in ponded depressions mostly influenced by rainwater accumulation or on alluvial ridges mostly influenced by overbank flooding. This report documents these findings.

5.4.4 Survey Report – Reevaluation of Pondberry (Lindera melissifolia) in the Big Sunflower and Yazoo Rivers Backwater Areas (2005). In June-July 2005, GSRC collected data from the same 62 colonies sampled in 2000.

5.4.5 USFS Pondberry Surveys in Delta National Forest. The USFS DNF conducted intermittent pondberry surveys as part of their pre-action evaluation of management activities in stands, and compiled a database incorporating surveys from 1988 to 2005 (USFWS 2007). We have been unable to locate any actual count data for these specific references to a database, other than those data in GSRC (2000, 2005) reports. Figure 8 shows the spatial distribution of known pondberry colonies according to the USFS. Many of these colonies were not included in 2000, 2001, 2005, or 2020 pondberry surveys, so it is not known whether pondberry colonies may still be extant at these sites. From DNF data, the USFS noted most known pondberry colonies occurred in the northeast portion and Compartment 39 of DNF, and that this spatial distribution did not appear to be the result of entering and surveying a disproportionate number of stands in these areas of DNF. At that time, approximately 32 percent of DNF had been surveyed for pondberry (USFWS 2007), and the surveyed stands appeared to be well-distributed across DNF. From prior hydrologic analyses, approximately 60 percent of DNF was considered below the 1-

year frequency elevation, with the remaining 40 percent of DNF above the 1-year frequency elevation. Twenty-four percent of the area below the 1-year frequency had been surveyed, with 23 colonies being located. Forty-three percent of the area above the 1-year frequency had been surveyed, with 159 colonies being located. Prior assessment suggested that there is a low probability of locating additional pondberry colonies in areas below the 1-year frequency, and the lack of pondberry colonies discovered on the majority of DNF was not the result of limited or disproportionate surveys.

5.4.6 Re-evaluation of Pondberry in the Delta National Forest (2020). During July 2020, the ERDC-EL revisited and assessed DNF GSRC colony sites within a 2-week timeframe. Pondberry was not found at any of the colony sites, but in the course of those surveys, 12 new colonies were identified and described. Subsequent to the July 2020 effort, the ERDC-EL determined that coordinates used for these surveys included a historical GIS projection error that resulted in all GSRC points being shifted 200m from their original location.

On 11 September, 2020, six ERDC-EL biologists met in the DNF for a one-day training effort to (a) enhance skills associated with pondberry identification, (b) finalize the protocol being used to assess a variety of pondberry colony and individual plant metrics, and (c) develop a consensus on how to assess metrics (e.g., canopy and understory cover). From 11-22 September, 2020, two ERDC-EL teams deployed daily, with corrected GIS data, to visit sampling plots. We visited all GSRC plots, along with the 12 newly discovered ERDC-EL colonies, and 10 colonies (McDearman Sites) provided by the USFWS. Williamson et al. (2019) documented pondberry in 2019 at three U.S. Forest Service (USFS) plots within DNF Compartments 9 and 25, and subsequently provided coordinates for these plots to facilitate assessments. Each team navigated to coordinates of previously documented pondberry locations in the DNF using a handheld GPS unit. Plot center was marked with flagging and a $1/5^{th}$ acre circular plot (52.7 foot radius) was established by stretching a foresters tape along cardinal directions. We searched each plot for PVC pipes used in 2005 to mark prior colony locations and survey points. At each point we conducted a meander search for pondberry within each of four quadrants for a minimum of five minutes; plots with dense groundcover components were allotted additional time per quadrant. As time allowed, we also conducted rapid, untimed searches for pondberry in adjacent areas outside of plots. In addition, we generally searched for pondberry while walking between plots and to and from forest access points. When pondberry was found, we marked individual plants with flagging at small colonies, and the perimeter of large colonies, for colony and associated habitat assessments. We defined distinct pondberry colonies as any occurrence separated by a distance >15 feet. We established a $1/10^{th}$ acre circular plot (37.2 ft radius) at the center of each colony and assessed each colony using the metrics described below.

5.4.6.1 Assessment metrics

(1) Describe site type
   a. Ridge – Highest elevations in the DNF, typically dominated by less water-tolerant vegetation, and often surrounded by lower elevation flats and depressions.
   b. High flat – higher elevation sites than surrounding landscape, but below ridges.

c. Low flat- lower elevation sites than surrounding landscape with evidence of recent flooding, often adjacent to a depression.
d. Depression – obvious wetland depression in locally low-elevation sites that either held water at the time of surveys, or recently were inundated.

(2) Conduct qualitative assessment of site wetness at soil surface
   a. Measurable standing water
   b. Saturated soil, but no measurable water depth
   c. Moist but not saturated soil
   d. Dry soil

(3) Record existing water depth (centimeters; cm) at plot with one representative measurement.

(4) Record maximum height (cm) of any water marks or moss trim lines present on trees within the assessment plot.

(5) Record any evidence of current or prior disturbance including cut stumps, beaver activity, feral pig activity, large tree-fall gaps, etc. within a 50-foot radius of plot center.

(6) Record distance and azimuth from the center of the colony to the nearest upper-canopy tree.

(7) Record number, height, and diameter at soil surface (with small calipers) of pondberry stems in each colony. For small colonies (e.g., < 50 stems), measure each individual plant. For medium-sized colonies (e.g., 50-150 stems), measure every other plant. For large colonies, measure a representative number of plants such that at least 50 stems are measured (e.g., every 5^{th} stem in a colony of 250 plants).

(8) Colony Photo Documentation: Take digital image from each cardinal direction from outside of colony facing inward toward colony, such that the entire colony is in view for each image. Images captured in the following sequence: N, E, S, W.

(9) Record number of fruiting pondberry stems, if fruit present.

(10) Qualitative assessment of colony Health:

   a. Note presence and severity of (a) stem dieback/damage, (b) herbivory, (c) chlorotic leaf tissue, and (d) necrotic leaf tissue.

0 — absent or negligible (present on ≤10% of stems; if colony is comprised of a single stem then affecting ≤10% of approximate total leaf area affected, dieback/damage on no more than one primary or secondary branch).

-1 — moderate (present on >10% but ≤25% of stems; if colony is comprised of a single stem, affecting ≥10% but ≤25% of the approximate total leaf area, dieback/damage on more than one primary or secondary branch but ≤25% of total primary and secondary branches).

-2 — major (>50% of stems; if the colony is comprised of a single stem, ≥50% of the approximate total leaf area, dieback/damage on ≥25% of primary or secondary branches.

b. Overall health rating of colony based on deductions from prevalence of stem dieback/damage, herbivory, chlorotic and necrotic foliage. (0 = excellent, -1 = good, -2 = fair, and ≤-3 = poor)

(11) Measure canopy cover with a spherical, convex mirror densiometer at the end of each 37.2 foot azimuth (cardinal directions) and obtain an average canopy cover value for the plot.

(12) Determine basal area by measuring diameter at breast height (DBH) of all trees within the plot. Record tree species for each measurement.

(13) Assess stand maturity class based on DBH: most trees approximately 6", 6-18", >18", or Mixed sizes.

(14) Record distance to nearest water body if visible, or determine remotely from aerial imagery.

(15) Measure basic colony dimensions (length x width) with a meter tape or by using a rangefinder.

We revisited 50 prior-documented GSRC pondberry colonies within the DNF and found above-ground growth of pondberry at 17 (34%) of these sites (Appendix 1, Table A1). At most sites, we found PVC pipe(s) in the immediate vicinity indicating that our coordinates were accurate. The mean and median number of stems at these 17 colonies was 7 and 34.6, respectively (range 1-319 stems). For the 50 GSRC plots we were able to visit and assess within DNF, the total number of pondberry stems within plots in 2020 (n=589) declined by 95.0% and 90.7% from 2001 (n=11,839) and 2005 (n=6,302), respectively. Only one colony (GSRC 39) had more pondberry than previously documented in 2000 or 2005 (Appendix 1, Table A1). Measures of herbivory, chlorosis, dieback/damage, necrosis, and fungal pathogens (Appendix 1, Table A2) were noted at multiple colonies, though most colonies appeared relatively healthy. We will combine these measures into an index of colony health for future analyses of colonies.

During the course of foot travel from access points to GSRC colony locations during both July and September 2020, we discovered 15 new pondberry colonies (Appendix 1, Table A1; Appendix 2). The mean (39 stems) and median (6.5 stems) stem count for these colonies was similar to that found during the same timeframe at the GSRC colonies. We found a relatively large number of pondberry stems at two of the three USFS plots (565 and 1,482 stems) most recently assessed in 2019. We also found pondberry at all of the McDearman plots (range 8 to ~8,000 stems) (Appendix 1, Table A1). There were no available data at the time of this draft for which to compare historical pondberry metrics at USFS or McDearman plots to those gathered by ERDC-EL in 2020.

We found a total of 41 distinct extant colonies at all sites, plus one very large colony (or groups of colonies) encompassing McDearman plots 1, 2, 3, and 4. This latter site and associated colonies was extremely large with pondberry distributed over approximately one acre. We visually estimated this plot containing multiple colonies collectively with >8,000 stems. The site

was too large to completely characterize given time constraints of conducting detailed habitat sampling at all DNF sites with and without colonies. However, two GSRC plots (GSRC 42, GSRC 43) fell within the boundaries of this area and metrics from these two points should sufficiently characterize overall habitat characteristics for the larger site.

For all plots combined, mean canopy closure at pondberry colonies (96.8%, n=42) was similar to plots without pondberry (95.3%, n=38). Likewise, understory cover at pondberry colonies (42.5%, n=38) was also similar to plots without pondberry (47.8%, n=38) (Appendix 1, Table A1). We found disturbance at many colony sites to include presence of large tree-fall gaps, and evidence of moderate to heavy rooting by feral pigs (Appendix 1, Table A3).

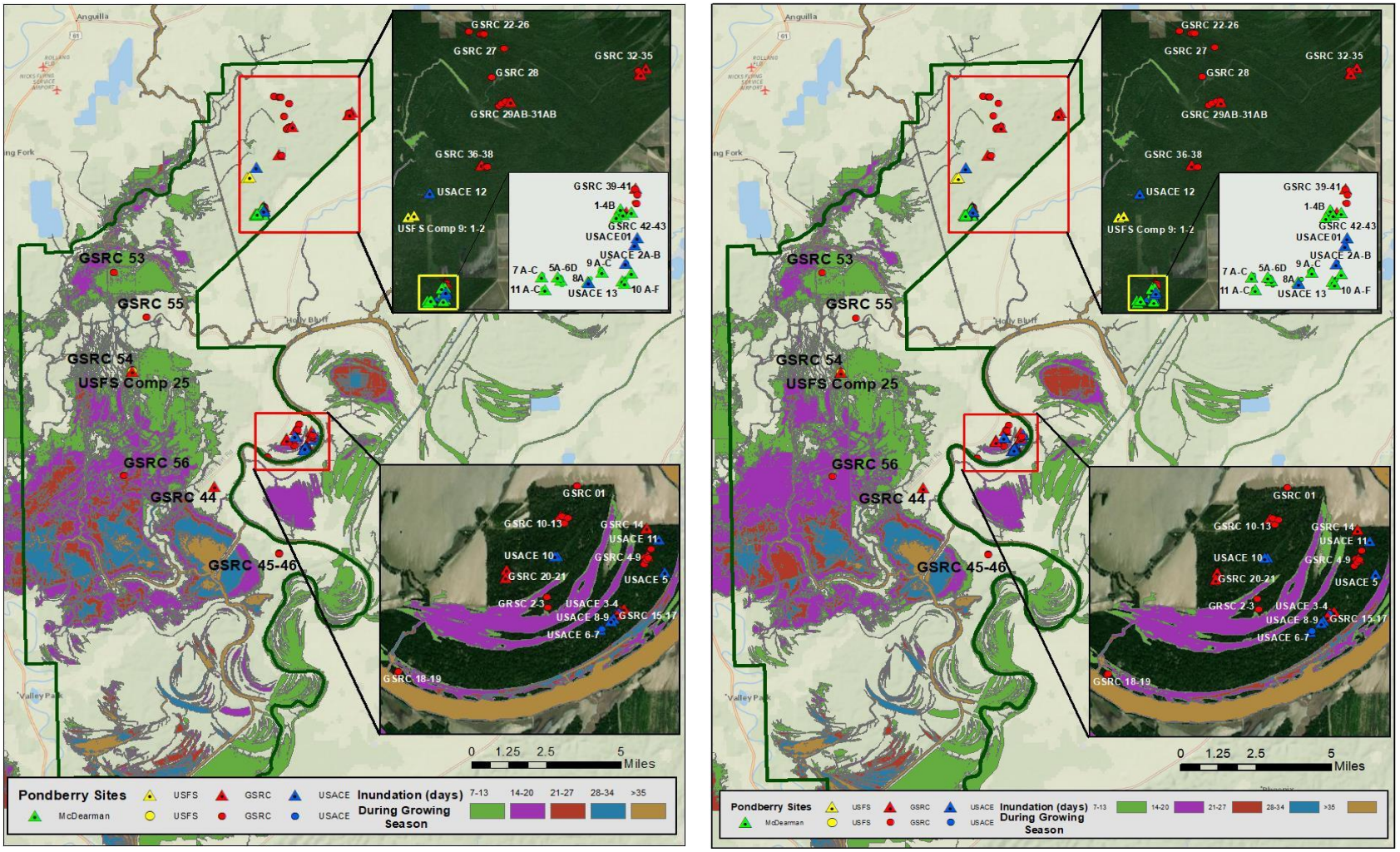

Figure 10. Sites surveyed within the Delta National Forest during July and September 2020 for the endangered pondberry. Surveys included previously known sites (i.e. McDearman, U.S. Forest Service, and GSRC) as well as newly discovered sites (i.e. USACE). Sites where pondberry colonies were present in 2020 are represented by triangles and sites lacking presence of pondberry are represented by circles. The number of days inundated during the growing season were overlayed with pondberry sites for the Period-of-Record without pump operations (left) and with pump operation (right).

Table 4. Pondberry colony surveys, September 2020, and days flooded during growing season at each colony during the Period of Record (number of days in each category is the same for both with and without pump conditions).

Pondberry Present	Days Flooded During Growing Season	Pondberry Sites without Pump	Pondberry Sites with Pump
No	<7	30	30
	7-13	2	2
	14-20	1	1
	21-27	0	0
	28-34	0	0
	>35	0	0
	Total	33	33
Yes	<7	46	46
	7-13	1	1
	14-20	0	0
	21-27	0	0
	28-34	0	0
	>35	0	0
	Total	47	47

Table 5. Number of pondberry extant and extinct pondberry colonies (September 2020) within each flood frequency interval, with (base) and without (pump) project.

		Flood Frequency Interval (years)							
	Pondberry Present	**1**	**2**	**5**	**10**	**20**	**50**	**100**	**>100**
Base	No	3	2	3	7	9	9	0	0
	Yes	1	0	15	25	3	3	0	0
	Total	4	2	18	32	12	12	0	0
Pump	No	3	0	2	3	4	8	5	8
	Yes	1	0	2	14	22	3	2	3
	Total	4	0	4	17	26	11	7	11

Table 6. General statistics for sites containing pondberry (n=47) during September 2020 surveys in DNF.

	Flood Frequency Interval (Years; Base Conditions)					
Metric	**1**	**5**	**10**	**20**	**50**	**Mean (All Years)**
Mean of # Live Stems	87.0	143.7	444.0	12.3	7.3	274.3
Mean of # Dead Stems	0.0	1.0	3.3	0.0	0.5	2.0
Mean Water Depth (cm)	0.0	2.3	1.0	0.0	0.0	1.3
Mean Height of Moss/ Water Line (cm)	0.0	142.1	97.0	44.0	71.0	106.8
Mean Dist Nearest Canopy Tree (ft)	20.0	17.1	13.7	12.6	24.5	15.6
Mean % Canopy Closure	98.7	95.5	98.0	97.9	91.5	96.6
Mean % Understory Cover	77.5	43.7	30.0	49.2	66.7	39.1
Mean Vine Cover (%)	20.0	9.6	5.6	0.7	15.3	7.9
Mean Mean Stem Ht. (cm)	39.5	28.0	33.3	24.8	25.0	30.4
Mean Stem Diameter (mm)	3.3	3.2	3.4	2.4	2.8	3.2

Table 7. Comparison of number of stems, stem height, and stem diameter at pondberry colony sites surveyed during July and September 2020, Delta National Forest, Mississippi.						
ERDC Plot #	**Stems Sept**	**Stems July**	**Stem Ht Sept**	**Stem Ht July**	**Stem Dia Sept**	**Stem Dia July**
1 (1a)	22	1	47.5	61.98	4.2	4.27
2 (2a)	4	1	7.5	31.75	1.1	6.53
3	0	3	-	25.4	-	2.95
4	14	11	39	46.23	4.6	4.45
5	42	37	22.5	26.42	3.0	2.85
6	2	2	18.0	40.89	4.5	3.89
7	0	1	-	42.67	-	2.06
8	2	2	28	38.10	4.77	3.56
9	16	10	21	27.43	2.57	2.57
11	1	1	-	17.78	-	2.01

For the 2000-2005 surveys, the ERDC-EL was able to glean stem count data for these years (Table 1). We noted a significant decline from 2005 to 2020 in the number of known pondberry colonies in the DNF. Only 17 of 50 GSRC colony sites had detectable stems. Similarly, for extant colonies, the number of stems declined remarkably from earlier 2000 and 2005 surveys. We also observed several plots that have likely changed dramatically since they were evaluated in 2005. Some have high densities of vines due to treefall gaps/storm damage, and seed-tree cuts, and at these sites it would be difficult for pondberry to compete. Because our surveys occurred in September and well into the growing season (post-flood), we believe colony conditions were representative of current colony stem count and health. Such an apparent dramatic decline in colony numbers and size is concerning, though it is prudent to consider the depth and duration of floodwater inundation within the Yazoo Basin during both 2019 and 2020 before drawing any conclusions about the overall status of pondberry in the DNF. Future analyses will include a focus on elevation, flood frequency, inundation length, and maximum flood height of each colony site. Analyses will include thoroughly analyzing all colony data via multivariate statistical testing to help identify potential colony metrics that contribute to optimal colony growth conditions.

Because the ERDC-EL discovered 15 new colonies at 12 sites during the course of fieldwork within limited portions of the DNF, we believe that the distribution and abundance of pondberry likely is higher than currently documented within the DNF. More extensive discovery surveys may be warranted during early spring, when pondberry is flowering. Flowering phenology is typically earlier than leaf-out of most other understory vegetation and may be relatively easy to detect across the landscape if extensive transect surveys are conducted with multiple personnel. It also is feasible to consider collecting aerial imagery if pondberry flowering occurs prior to canopy tree leaf-out.

6 Avoidance, Minimization, and Conservation Measures

The primary mitigation associated with the Proposed Plan includes (a) acquisition and reforestation/conservation features on up to 2,700 acres of agricultural lands through perpetual easements from willing sellers, and (b) installation of 34 supplemental low flow groundwater wells north of the Yazoo Study Area, in Washington, Bolivar, and Coahoma counties, Mississippi, and within the project drainage area. For mitigation lands, approximately 2,100 acres of cleared land are potentially available below elevation 87.0 feet, NGVD, and the remaining acreage needed to reach up to the 2,700 acres will be acquired at or near 87.0 ft. NGVD. Because there are no known pondberry colonies at or below 87 ft. NGVD in the DNF (and all but three colonies occur above 91 ft. NGVD), and the supplemental low flow groundwater wells are proposed to only offset unavoidable losses to aquatic resources, neither of these features can be considered conservation measures for pondberry colonies in the DNF.

6.1 Endangered Species Act Section 7(a)(1) Conservation Planning

The MVK believes that the most beneficial means of promoting pondberry populations in the DNF is through proactive conservation planning. Section 7 of the Endangered Species Act provides that federal agencies consult with either the USFWS or NMFS (collectively, the Services) to insure that their actions do not jeopardize the continued existence of threatened or endangered species, or adversely modify their critical habitats. Section 7 is split into multiple parts that relate to how action agencies cooperate with the Services to protect species. The USACE works with the Services primarily via formal and informal consultations under Section 7(a)(2) of the Endangered Species Act, which typically leads to the issuance of Biological Opinions by the Services that mandate special measures action agencies must follow to protect threatened and endangered species in the course of their actions.

There is significantly less familiarity with, and utilization of, the preceding Section 7(a)(1). In 2017, the USFWS Jackson, Mississippi Ecological Services Office, and the ERDC-EL collaborated on a publication (Hartfield et al. 2017) to describe the benefits of interagency cooperation through Section 7(a)(1). This approach proved successful in contributing to the delisting of the interior population of the Least Tern (*Sternula antillarum athalassos*). Many of the proactive conservation activities that have been implemented during the past several decades on USACE lands pertain directly to this section which describes voluntary conservation measures by federal agencies for federally listed species. This section specifies that agencies' duties to conserve threatened and endangered species can apply widely to programs and is not limited to individual actions. Thus, agencies can distribute conservation obligations program-wide, as well as achieve conservation opportunities outside of defined action areas to attain compliance with the ESA in a way that promotes efficiency, cost effectiveness, ingenuity, and improved conservation outcomes through increases in species baselines. Thus, a more proactive use of Section 7(a)(1) conservation actions provides a way USACE can gain improved operational efficiency and flexibility in executing mission requirements (Hartfield et al. 2017).

In addition, the flexibility that can be gained through 7(a)(1) conservation programs enables greater synergy with stakeholder initiatives and promotes strategic collaboration and resource leveraging which can significantly increase objectives achievement and program sustainability. It also allows opportunistic mitigation of past, present, or future adverse effects of agency actions

by raising the species population and/or habitat baselines, which may reduce the potential of future interagency conflicts under Section 7(a)(2) and increase operational flexibility and mission sustainability (Hartfield et al. 2017).

6.1.2 Components of Section 7(a)(1) Conservation Programs. There is no formal template for Section 7(a)(1) conservation programs, and their design is currently flexible and adaptable. Important components would include relating the federal agencies role and contribution to the species baseline within their regulatory footprint, identification of research and monitoring needs relative to agency actions, and management strategies under its authorities to minimize adverse impacts ***and*** benefit (i.e., conserve) the species (Hartfield et al. 2017). The obvious intent of section 7(a)(1) is to raise the species status baseline within the scope of the federal agency mission program footprint. In general, a Section 7(a)(1) conservation program links the authorized purpose of the mandated mission program with the status of listed species potentially benefitted or adversely affected by the mission program, and presents a general and defined strategy for the conservation of the species and their habitats.

6.2 Recommended Potential Conservation Actions by USACE

In 2001, the U.S. Army Corps of Engineers, Vicksburg District, entered into a 7-year, $5 million interagency agreement with the USFS, to initiate various biological and ecological investigations on pondberry. The Agreement was entered into pursuant to Section 7(a)(l) of the ESA. These ongoing research activities were specifically designed to address recovery tasks described in the USFWS (1993) Pondberry Recovery Plan. Attachment A of the USFWS (2007) Biological Opinion addressed tasks in the Recovery Plan and are also being conducted in accordance with Section 7(a)(l) of the ESA.

At that time, the Corps proposed to conduct the following activities:

> (1) Propagation and stocking of approximately 40,000 pondberry plants at Mahannah Wildlife Management Area and Panther Swamp National Wildlife Refuge, at or below the 1-year Backwater flood frequency.
>
> (2) Establishment of field experiments within experimental plots in DNF, Sharkey County, MS, to evaluate the effects of flood frequency, sunlight, competition, and pathogens on pondberry. Proposed treatments included (a) flood frequencies at 1, 2, 5, 10, and 15 years; (b) stand sunlight manipulated through light thinning, heavy thinning and control; and (c) competition investigated with herbicide treatment and control.

During the approximate timeframe between 2001 and 2015, the USFS conducted a wide variety of research investigations under the Agreement resulting in a multitude of reports and peer-reviewed publications. To our knowledge, the majority of these investigations occurred in the laboratory, or in limited field settings. These research investigations yielded significant insight on the biology and ecology of pondberry relative to flooding and light requirements, much of which can now be transferred to field settings for direct management treatments that could be monitored over time in an experimental framework.

There are a variety of management opportunities that would assist in increasing the baseline of pondberry in the DNF. The management practices listed below could provide opportunities to better understand how pondberry responds to changes in stressor levels, which ultimately could provide insight into ways to both conserve and recovery the species.

6.2.1 Experimental canopy thinning. Pondberry often is considered a disturbance-dependent species (Lockhart 2016). For maximum stem growth, it requires between 40 and 70 percent full sunlight. Populations in the DNF, and MAV as a whole, are considered relict populations persisting despite a reduction in natural disturbances that have altered canopy closure. In the DNF, light levels are low, often as low as 5%, which impacts pondberry growth and vigor (Lockhart 2016). Some researchers have experimentally manipulated light availability for pondberry in the laboratory setting (Unks et al. 2014; Lockhart et al. 2013, 2015, 2017, 2018). For example, Lockhart et al. (2013) showed that pondberry plants raised under 37 percent light had greater stem length growth than plants raised beneath 70 percent or 5 percent light. Further, Lockhart et al. (2015) further demonstrated that pondberry plants raised in 5 percent light, and then subsequently provided with additional sunlight (i.e., 70 and 37 percent) released and grew significantly larger. Best stem growth occurred at around 40 percent of full sunlight (Lockhart 2016). In the Atlantic Coastal Plain, Beckley (2012) suggested that pondberry is a disturbance-dependent species (e.g., disturbances that decrease canopy cover), which was also suggested to be true for pondberry in the MAV (Lockhart et al. 2012). Lockhart (2016) suggested that forest management that increased light levels reaching the understory, and vegetation control to reduce competition, could be used in combination to increase growth of pondberry. One caveat to such an approach is how competitors such as *Brunnichia ovata* also respond to increased light levels (Hawkins et al. 2016), highlighting some complexities and potential tradeoffs with reducing canopy cover above pondberry colonies.

Mean canopy closure at pondberry colonies (96.8%, n=42) was similar plots without pondberry (95.3%, n=38) during ERDC-EL 2020 assessments. This same metric has been measured by multiple researchers who have found similar canopy cover results (GSRC 2001, GSRC 2005). Therefore, silvicultural treatments could be designed at extant pondberry colonies in the DNF to increase the amount of available light reaching the understory. Field measurements could be made over time, and compared with control sites to determine the efficacy of this management action in increasing pondberry growth rates. Lockhart (2016) provided a reasonable outline for designing such experiments, along with caveats regarding need for special use permits from USFWS, NEPA requirements and environmental reviews by the USFS, and the inherent difficulties of experimental field project designs on a rare species.

6.2.2 Micropropagation and Transplanting. Several investigators have met with some success in propagating, and in some cases, outplanting pondberry to natural environments (Wright 1989, Devall et al. 2004, Hawkins et al. 2007). Wright (1989) sowed pondberry seeds in a greenhouse and transplanted seedlings to an existing colony in spring in Arkansas; survival after 4 – 5 months ranged from 10% – 89%. Devall et al. (2004) also met with some success with outplanting, with high survival in the short-term but low survival after three years. Hawkins et al. (2007) successfully propagated more than 10,000 pondberry stecklings in both controlled and field settings in Mississippi.

More thorough, transplant experiments should be designed under varying light and hydroperiod treatments, at various elevations throughout the DNF. The MVK, ERDC-EL, and USFS should collaborate to design and implement such experiments.

6.2.3 Herbivory and Feral Hog Rooting. Though we found no specific research on the potential effects of feral hogs on pondberry, hogs are often mentioned in the literature (e.g., Gustafson 2011, USFWS 2014, Martins et al. 2015), and in many online fact sheets, as significant sources of disturbance (e.g., through rooting, grazing and trampling) to pondberry colonies. In fact, Martins et al. (2015) noted herbivory by multiple organisms in an investigation that included installation of wildlife trail cameras at colonies. During 2020 assessments of GSRC colony sites in the DNF, the ERDC-EL found evidence of feral hog disturbance at no fewer than 10 (20%) of 50 colony sites. The following represent potential opportunities for investigations that seek to determine the relative impacts of feral hogs on pondberry colonies in the DNF.

(a) Design a replicated field experiment that includes the installation of exclosure fencing around pondberry colonies. Control plots also would be established to compare rooting, soil disturbance, herbivory, and other impacts inside and out of exclosures.
(b) Install wildlife trail cameras at multiple points in and near colonies to monitor feral hog (and other potential herbivores, including white-tailed deer [*Odocoileus virginianus*]) activity.
(c) Identify whether any prior or ongoing investigations are monitoring the distribution and abundance of feral hogs within the DNF.

6.2.4 Long-term Monitoring Plan. Pondberry monitoring in the DNF has been ongoing but very intermittent in the DNF for three decades. Though the ERDC-EL conducted a thorough investigation of 50 pondberry colonies also monitored by GRSC in 2000 and 2005, and assessed other colony sites lacking prior monitoring information (i.e., McDearman and USFS plots), there is insufficient data to conduct a thorough assessment of the status of pondberry in the DNF. The same is true for adequately addressing impacts of hydrology (flood frequency, inundation depth and duration) on pondberry colony health and persistence.

A main focus (and disagreement between USFWS and USACE) of the 2007 BO (USFWS 2007) was on the effects of flood frequency on pondberry colonies. The currency used to test hypotheses regarding potential impacts of hydroperiod on pondberry colonies was number of stems per colony. Stem counts between 2000 and 2005 showed an apparent decline at most colonies. In reviewing GSRC (2000, 2005) reports, it was not clear exactly how those investigators defined plot sizes for stem counts, and no raw data were available in GSRC (2005) for which to adequately determine whether 2000 and 2005 techniques were identical. To further this confusion, Gulf South Biological (2001) also visited GSRC pondberry colonies and counted stems, noting "at almost all sites the number of stems counted….were less than the number of stems counted by Gulf South Research Corporation. In certain instances the flagged area where pondberry plants were concentrated was smaller than GSRC's original plot census." Pages 261-272 of 2007 BO (USFWS 2007) describe in detail and argue how various parties (including USACE, USFWS, and Applied Research and Analysis, Inc.) analyzed and interpreted data, and used estimates of statistical power to facilitate inference.

Without sufficient detail on how plot sizes and stem counts were made among years, much of the prior analyses, interpretations, and disagreements are exceptionally difficult to interpret and assess. USFWS (2007) stated there was a clear decline in stems from 2000 to 2005, but ERDC-EL cannot determine if the same methods were used between years to fully analyze count data for declines. Though a decline from 2005 to 2020 is readily apparent, these issues also make it exceptionally difficult to compare prior monitoring data with those collected in 2020.

We recommend the following monitoring:

(d) Because the ERDC-EL discovered 14 new colonies at 12 sites during the course of fieldwork within limited portions of the DNF, we believe that the distribution and abundance of pondberry likely is higher than currently documented within the DNF. More extensive discovery surveys are needed during early spring, when pondberry is flowering. Flowering phenology typically is earlier than leaf-out of most other understory vegetation and may be relatively easy to detect across the landscape if extensive transect surveys are conducted with multiple personnel. It also is feasible to consider collecting aerial imagery if pondberry flowering occurs prior to canopy tree leaf-out.

(e) Conduct extensive and annual monitoring of existing pondberry colonies, beginning in 2021, with a focus on those colonies identified during 2020 ERDC-EL discovery surveys. This monitoring should continue long-term to provide data before and after pump construction and operation. The MVK should consider integrating monitoring data into the Monitoring and Adaptive Management Plan (USACE 2020) that considers modifications to pump operation if data show that pump operations are negatively impacting pondberry.

(f) Conduct a more thorough investigation of the role of local hydrology (precipitation and flooding of local drainages via overbank or distributary flooding) on pondberry colonies.

7 IMPACT ASSESSMENT

The following section includes a status description of pondberry and how it will be affected by Project elements as well as the determination of effects for pondberry. The effects determination took into account implementation of the conservation measures listed above.

7.1 Effects Determination

Impact of No Action Alternative – Pondberry colonies in the Action Area investigated during 2020 primarily occur above the 1-year flood frequency elevation. No colonies occur below 87 ft. NGVD. In fact, only 4 (4.6%) current or historical colonies occur at or below elevation 91 ft. NGVD and the 1-year flood frequency (Figure 11). Twenty-eight (32.2%) colonies occur at or below the 5-year flood frequency, and the remainder occur in areas with flood frequencies between 10 and 50 years. With the no-action alternative, relatively few colonies are expected to receive significant inundation more frequent than every 10 years. This does not take into account local precipitation or hydrologic events (e.g., overbank flooding), which were not addressed in any significant manner in the SEIS. Berkowitz et al. (2019) showed that precipitation inputs sustain most wetlands in the Yazoo Basin, in addition to intermittent local flooding events. Under the no-action alternative, and since approximately 2000, pondberry populations appear to be in a steep decline, both in terms of number of stems and number of colonies.

Impacts of Proposed Federal Action – Based on extensive hydrologic and elevation data, no pondberry colonies occur below 87 ft. NGVD, and all four colonies occur at or below 91 ft. NGVD. Therefore, few pondberry colonies would be impacted under the Proposed Plan. Though flooding extent and duration will be reduced over a large portion of the Yazoo Study Area, again precipitation inputs shown to sustain wetlands in the Yazoo Basin (Berkowitz et al. 2019) in addition to local flooding events will still occur after implementation of the Proposed Plan. Though additional work is needed to fully understand the effects of flood frequency and duration of inundation, based on available data, this Project ***may affect but is not likely to adversely affect*** pondberry.

7.2 Cumulative Effects

Cumulative effects under the ESA are those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the Action Area (50 CFR 402.02). Future federal actions that are unrelated (i.e., not interrelated or interdependent) to the proposed action are not considered in this assessment because they will be subject to separate consultation pursuant to Section 7 of the ESA. Because all pondberry colonies addressed in this

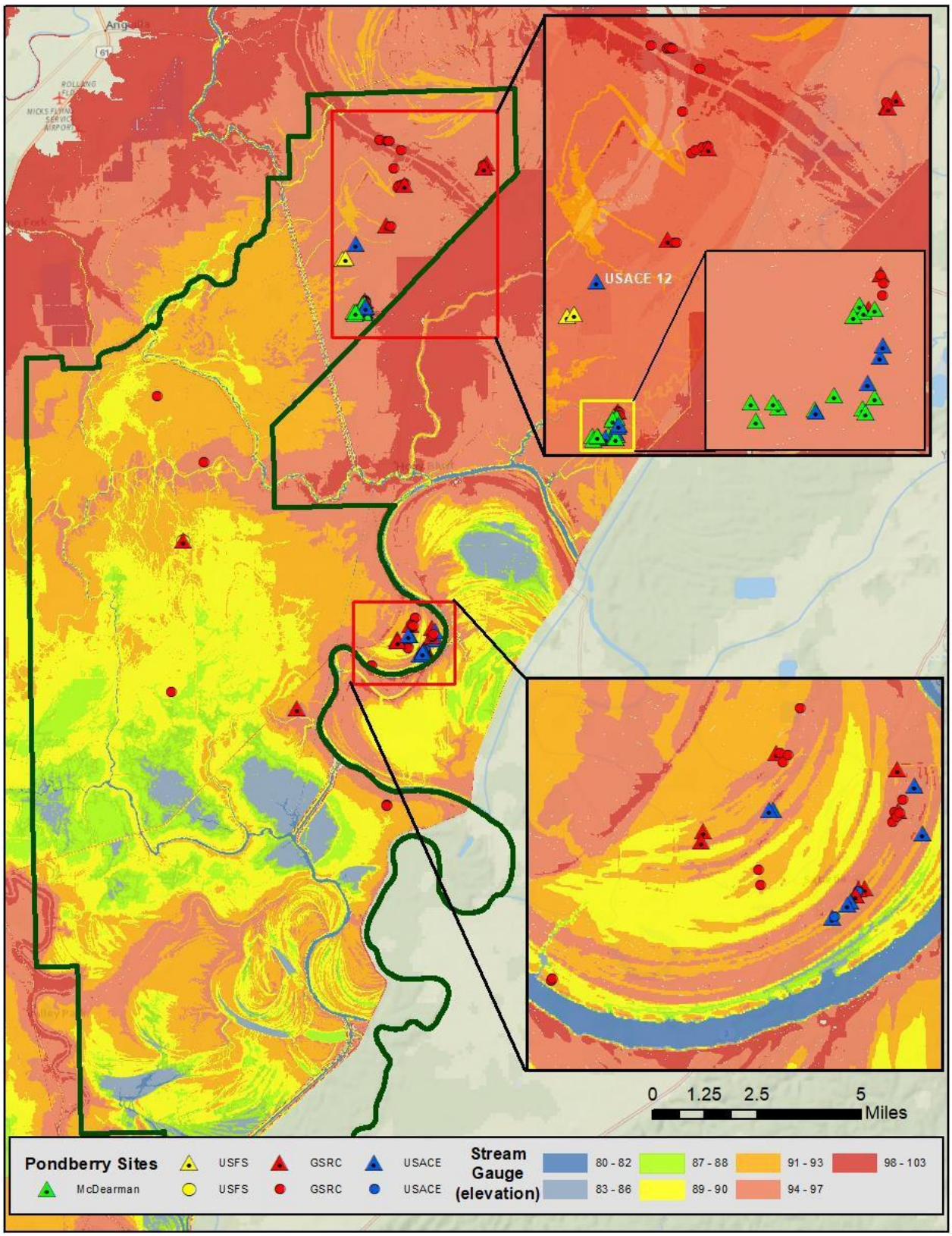

Figure 11. Stream gauge (elevation) in relation to 2020 pondberry sampling sites. Triangles represent extant colonies; circles represent former colonies where pondberry was not found.

BA for the Project within the Action Area occur on USFS lands, we do not anticipate significant external impacts to extant pondberry colonies. Some colonies in DNF do occur proximal to private agricultural inholdings, thus there is potential for land alterations and/or changes in hydrology due to ditching or by other means. Other potential impacts could occur due to alterations in hydrology within rivers and streams within the Action Area (e.g., Big Sunflower River) that result from actions and activities outside of the Action Area.

8 CONCLUSION AND DETERMINATION OF EFFECTS

The determination of effects is based on whether the proposed action (as defined in this BA) is likely to cause loss of potential occupied habitat, likelihood of loss of individual pondberry plants or colonies, and likelihood of disruption of reproduction and dispersal. Based on the above analysis, and assuming all conservation measures described above are in place and working as anticipated, the proposed action ***may affect, but is not likely to adversely affect pondberry.***

Pursuant to federal regulations, if, subsequent to the completion of this informal consultation the proposed action is revised either by: (1) selecting a different alternative or (2) adding more stringent mitigation measures through the NEPA process (or any other environmental review process) and new information or information not used in this analysis reveals effects of the action that may affect pondberry in a manner or to an extent that was not previously considered, then the federal agencies with jurisdiction for actions related to potential effects on such species would need to either request a subsequent concurrence that the proposed action was "Not Likely to Adversely Affect" pondberry or initiate formal consultation (50 CFR 402.16).

Please review the above and attached information and inform MVK as to whether or not you agree with our determinations. If you have any questions about the project or need additional information contact Ms. Sara Thames, Biologist/Environmental Manager at (601) 631-5894.

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Appendix 1

2020 Assessment Metric Results for Delta National Forest Pondberry Colonies

Table A1. Results of USACE ERDC-EL pondberry surveys conducted during September 11-22, 2020 in the Delta National Forest, Mississippi. Coordinates are generated using the spatial projection NAD83-UTM Zone 15N.

Site	Plot #	North	East	Distance from # USACE to USFWS (m)	Site Type	Pondberry Present	# Live Stems	Mean Stem Ht. (cm)	Mean Stem Diameter (mm)	# Dead Stems
GSRC	1	715226	3627838	0.0	High Flat	No	-	-	-	-
GSRC	2	714942	3626734	0.0	High Flat	No	-	-	-	-
GSRC	3	714953	3626632	11.0	High Flat	No	-	-	-	-
GSRC	4	715897	3627138	9.4	High Flat	Yes	3	24.6	2.2	0
GSRC	5	715860	3627060	6.5	High Flat	No	-	-	-	-
GSRC	6	715872	3627130	19.8	High Flat	No	-	-	-	-
GSRC	7	715884	3627098	22.5	High Flat	No	-	-	-	-
GSRC	8	(715902) Incorrect UTM, see USFWS	(3627124) Incorrect UTM, see USFWS	119.9	High Flat	No	-	-	-	-
GSRC	9	715929	3627215	12.5	High Flat	No	-	-	-	-
GSRC	10	715065	3627535	0.0	High Flat	Yes	1	13.0	1.7	-
GSRC	11	715106	3627468	0.0	High Flat	No	-	-	-	-
GSRC	12	715085	3627536	0.0	High Flat	No	-	-	-	-
GSRC	13	715140	3627522	0.0	High Flat	No	-	-	-	-
GSRC	14	715889	3627423	0.0	High Flat	Yes	12	28.8	3.8	-
GSRC	15	715672	3626615	0.0	High Flat	Yes	7	9.8	1.9	-
GSRC	16	715630	3626603	0.0	High Flat	Yes	7	39.0	4.6	-
GSRC	17A	715607	3626560	0.0	Ridge	Yes	1	17.0	2.0	-
GSRC	17B	715607	3626560	0.0	High Flat	Yes	1	55.0	4.0	-
GSRC	17C	715607	3626560	0.0	Ridge	Yes	5	16.0	2.3	-
GSRC	18	713529	3625978	0.0	High Flat	No	-	-	-	-
GSRC	19	713537	3625994	0.0	High Flat	No	-	-	-	-
GSRC	20	714551	3626930	1.4	High Flat	Yes	5	17.0	2.6	-
GSRC	21	714564	3627003	1.4	High Flat	Yes	3	10.7	2.4	-

GSRC	22	714136	3646271	35.1	Low Flat	No	-	-	-	-
GSRC	23	714176	3646280	5.7	Low Flat	No	-	-	-	-
GSRC	24	714193	3646286	16.5	High Flat	No	-	-	-	-
GSRC	25	714220	3646277	13.3	High Flat	No	-	-	-	-
GSRC	26	713861	3646324	17.0	High Flat	No	-	-	-	-
GSRC	27	714691	3645924	21.9	High Flat	No	-	-	-	-
GSRC	28	714398	3645205	21.5	High Flat	No	-	-	-	-
GSRC	29	714562	3644485	84.5	High Flat	No	-	-	-	-
GSRC	29A	714622	3644547	54.0	High Flat	No	-	-	-	-
GSRC	30	714739	3644601	7.5	High Flat	No	-	-	-	-
GSRC	31	714829	3644610	66.6	High Flat	No	-	-	-	-
GSRC	31A	714858	3644579	95.5	High Flat	Yes	9	21.2	2.4	-
GSRC	32A	717914	3645265	42.3	Low Flat	Yes	18	24.4	3.0	-
GSRC	32B	717901	3645292	63.8	Low Flat	Yes	4	29.8	2.1	-
GSRC	33	717889	3645297	55.9	Low Flat	No	-	-	-	-
GSRC	34	717872	3645356	70.0	Low Flat	No	-	-	-	-
GSRC	35	718046	3645430	5.7	Low Flat	Yes	24	23.4	2.6	-
GSRC	36	714149	3643016	19.5	High Flat	Yes	2	19.5	2.3	-
GSRC	37	714258	3642974	3.9	High Flat	No	-	-	-	-
GSRC	38	714294	3642977	41.4	High Flat	No	-	-	-	-
GSRC	39	713317	3640104	6.3	Low Flat	Yes	19	19.4	2.4	0
GSRC	40	713325	3640075	7.9	Depression	No	-	-	-	-
GSRC	41	713323	3640033	10.2	Depression	No	-	-	-	-
GSRC	42	713276	3639989	19.7	Low Flat	Yes	59	33.3	3.6	-
GSRC	43	713244	3639977	3.2	Low Flat	Yes	319	42.3	3.2	2
GSRC	44	710657	3624307	78.9	Low Flat	Yes	2	21.0	2.7	-
GSRC	45	(714127) Incorrect UTM, see USFWS	(3620580) Incorrect UTM, see USFWS	1265.5	High Flat	No	-	-	-	-
GSRC	46	(714130) Incorrect UTM, see USFWS	(3620533) Incorrect UTM, see USFWS	1284.9	High Flat	No	-	-	-	-

GSRC	53	705245	3636416	7.9	Low Flat	No	-	-	-	-
GSRC	54	706246	3630826	14.1	High Flat	Yes	87	39.5	3.3	-
GSRC	55	707044	3633857	1.8	High Flat	No	-	-	-	-
GSRC	56	705801	3624959	25.6	High Flat	No	-	-	-	-
FS Comp	25	706256	3630801	na	-	No	-	-	-	-
FS Comp	9_1	712435	3641731	na	High Flat	Yes	1482	70.5	4.9	-
FS Comp	9_2	712569	3641766	na	High Flat	Yes	565	56.2	4.5	0
McDearman	PL1	713247	3640004	na	Low Flat	Yes	8,000	-	-	
McDearman	PL2	713259	3639978	na	Low Flat	Yes		-	-	
McDearman	PL3	713297	3639989	na	Low Flat	Yes		-	-	
McDearman	PL4	713228	3639966	na	Low Flat	Yes		-	-	
McDearman	PL5a	712958	3639673	na	High Flat	Yes	47	31.3	3.5	-
McDearman	PL5b	712974	3639659	na	High Flat	Yes	169	37.9	3.2	-
McDearman	PL7	712881	3639674	na	High Flat	Yes	80	47.9	4.2	-
McDearman	PL8	713096	3639651	na	Low Flat	Yes	166	27.2	3.1	-
McDearman	PL9	713161	3639698	na	Low Flat	Yes	224	30.0	3.3	-
McDearman	PL10	713257	3639654	na	High Flat	Yes	59	36.3	3.3	-
McDearman	PL10A	713297	3639693	na	High Flat	Yes	8	29.3	3.2	0
McDearman	PL10B	713268	3639641	na	High Flat	Yes	90	33.7	3.8	11
McDearman	PL11	712899	3639612	na	High Flat	Yes	124	53.0	4.7	-
USACE-ERDC	1 (1a)	713314.00	3639829.00	na	High Flat	Yes	22	47.45	4.17	-
USACE-ERDC	1b	713327.00	3639866.00	na	High Flat	Yes	65	31.35	3.57	-
USACE-ERDC	2 (2a)	713273.00	3639740.00	na	High Flat	Yes	4	7.5	1.1	-
USACE-ERDC	3	715618.00	3626594.00	na	High Flat	Yes	-	-	-	-
USACE-ERDC	5	716065.00	3626985.16	na	Depression	Yes	42	22.5	3.0	2
USACE-ERDC	6	715450.00	3626409.61	na	Low Flat	Yes	2	18.0	4.5	-
USACE-ERDC	7	715462.00	3626417.08	na	Ridge	Yes	-	-	-	-
USACE-ERDC	8	715555.00	3626501.00	na	Low Flat	Yes	2	28	4.77	-
USACE-ERDC	9	715573.00	3626523.00	na	Ridge	Yes	16	21	2.57	-
USACE-ERDC	10	715028.58	3627126.92	na				na	na	
USACE-ERDC	10a	715018.00	3627142.00	na	Low Flat	Yes	1	26.0	3.1	1
USACE-ERDC	10b	715046.00	3627142.00	na	Depression	Yes	7	25.6	2.9	-

USACE-ERDC	11	716008.00	3627310.33	na	-	Yes	1	-	-	-
USACE-ERDC	12	712939.00	3642318.00	na	High Flat	Yes	6	34.3	3.5	-
USACE-ERDC	13	713099.00	3639645.00	na	High Flat	Yes	300	55.1	4.9	>25

Table A2. Results of USACE ERDC-EL pondberry surveys conducted during September 2020 in the Delta National Forest, Mississippi. Coordinates are generated using the spatial projection NAD83-UTM Zone 15N.

Site	Plot #	Colony Length (ft)	Colony Width (ft)	Colony Area (ft^2)	Soil Cond.	Water Depth (cm)	Moss/ Water Line (cm)	Dist Nearest Canopy Tree (ft)	Bearing Nearest Canopy Tree	% Canopy Closure	% Understory	Vines (%)
GSRC	1	-	-		Moist	0	0	39	80	70.4	65	60
GSRC	2	-	-	-	Moist	0	170	17	270	96.6	50	5
GSRC	3	-	-	-	Moist	0	190	19	55	98.2	50	10
GSRC	4	1.8	1	1.8	Moist	0	-	28.3	32	87.5	82.5	15
GSRC	5	-	-	-	Dry Soil	0	26	4.9	19	97.1	72.5	1
GSRC	6	-	-	-	Dry Soil	0	99	25.9	272	82.8	45	10
GSRC	7	-	-	-	Dry Soil	0	48	5	85	99.5	40	10
GSRC	8	-	-	-	Dry Soil	0	69	-	-	99.5	27.5	-
GSRC	9	-	-	-	Dry Soil	0	42	33	20	93.8	82.5	25
GSRC	10	0.35	0.25	0.0875	Moist	0	34	11	250	98.2	65	10
GSRC	11	-	-	-	Moist	0	0	5	290	87.0	53	30
GSRC	12	-	-	-	Moist	0	24	14	20	96.6	47.5	40
GSRC	13	-	-	-	Moist	0	9	23	130	68.0	82.5	70
GSRC	14	9.9	3.9	38.61	Dry Soil	0	115	7.4	290	81.0	62.5	5
GSRC	15	-	-	-	Moist	0	179	28.6	242	97.4	65	10
GSRC	16	-	-	-	Moist	0	179	28.6	242	97.4	65	10
GSRC	17A	-	-	-	Moist	0	153	27	308	98.7	25	5
GSRC	17B	-	-	-	Moist	0	188	18.8	12	99.7	35	5
GSRC	17C	-	-	-	Dry Soil	0	153	31.5	268	99.0	27.5	10
GSRC	18	-	-	-	Moist	0	205	7.5	70	94.8	32.5	35
GSRC	19	-	-	-	Moist	0	150	20	170	96.1	52.5	35
GSRC	20	3	1	3	Moist	0	154	2.5	284	84.7	50	20
GSRC	21	1	1	1	Moist	0	215	11.4	334	98.7	35	5
GSRC	22	-	-	-	Moist	0	0	12	188	100.0	47.5	5
GSRC	23	-	-	-	Moist	0	14	8.6	350	100.0	60	5
GSRC	24	-	-	-	Moist	0	23	16.1	162	98.7	57.5	5
GSRC	25	-	-	-	Moist	0	13	17.3	270	99.2	65	5

GSRC	26	-	-	-	Moist	0	101	5.7	200	99.7	65	5
GSRC	27	-	-	-	Dry Soil	0	7	31.8	144	98.2	62.5	5
GSRC	28	-	-	-	Moist	0	45	18.4	82	98.4	72.5	10
GSRC	29	-	-	-	Moist	0	27	19.2	216	98.2	32.5	5
GSRC	29A	-	-	-	Dry Soil	0	72	22.6	277	98.4	32.5	10
GSRC	30	-	-	-	Moist	0	38	10.1	290	99.7	53.75	5
GSRC	31	-	-	-	Dry Soil	0	12	9	227	100.0	52.5	5
GSRC	31A	5	6	30	Dry Soil	0	25	23	24	99.5	70	1
GSRC	32A	17	14	238	Dry Soil	0	22	20.6	0	96.4	52.5	1
GSRC	32B	-	-	-	Dry Soil	0	30	9.7	133	98.2	65	1
GSRC	33	-	-	-	-	0	72	23	22	97.1	32.5	0
GSRC	34	-	-	-	Dry Soil	0	74	29.4	180	99.2	17.5	1
GSRC	35	-	-	-	Dry Soil	0	77	5.1	232	96.1	12.5	0
GSRC	36	3.2	0.5	1.6	Dry Soil	0	61	15.6	26	97.4	42.5	5
GSRC	37	-	-	-	Dry Soil	0	11	8.5	26	96.6	50	<1
GSRC	38	-	-	-	Dry Soil	0	22	16.7	326	98.4	65	5
GSRC	39	17	17.5	297.5	Moist	0	92	4	230	93.5	27.5	1
GSRC	40	-	-	-	Saturated	0	138	34	260	99.7	7.5	0
GSRC	41	-	-	-	Moist	0	108	20.9	216	99.5	7.5	<1
GSRC	42	55.4	18.6	1030.44	Moist	0	98	29	120	98.2	38.75	1
GSRC	43	66.9	31.8	2127.42	Moist	0	96	14.3	135	97.9	22.5	1
GSRC	44	3	1	3	Moist	0	48	10	210	98.4	14.5	1
GSRC	45	-	-	-	Dry Soil	0	230	9.4	192	96.9	87.5	1
GSRC	46	-	-	-	Dry Soil	0	225	3.7	354	98.4	55	1
GSRC	53	-	-	-	Dry Soil	0	214	4	90	92.7	52.5	1
GSRC	54	42	42	1764	Dry Soil	0	0	20	130	98.7	77.5	20
GSRC	55	-	-	-	-	0	70	18	340	92.7	22.5	40
GSRC	56	-	-	-	Dry Soil	0	28	10.8	345	99.5	27.5	1
FS Comp	25	-	-	-	-	-	-	-	-	-	0	-
FS Comp	9_1	86	84	7224	Dry Soil	0	58	5	58	93.5	57.25	5
FS Comp	9_2	88	82	7216	Dry Soil	0	54	11.1	358	97.4	22.5	5
McDearman	PL1										0	

McDearman	PL2										0	
McDearman	PL3										0	
McDearman	PL4										0	
McDearman	PL5a	40	40	1600	Dry Soil	0	80	16	350	98.7	41.25	15
McDearman	PL5b	70	90	6300	Dry Soil	0	92	22	90	98.2	36.25	5
McDearman	PL7	46	17	782	Dry Soil	0	87	15	190	97.9	68.75	15
McDearman	PL8	46.9	56.8	2663.92	Moist	0	98	17.9	207	99.7	11.25	<1
McDearman	PL9	52.8	44.3	2339.04	Moist	0	120	23.3	246	99.7	30	1
McDearman	PL10	79.7	57.1	4550.87	Moist	0	96	15.2	321	99.7	22.5	5
McDearman	PL10A	31.9	2	63.8	-	0	111	9	236	99.5	32.5	5
McDearman	PL10B	80	50	4000	Moist	0	96	8	95	98.4	25	5
McDearman	PL11	90	50	4500	Dry Soil	0	80	14	45	98.7	56.25	10
USACE-ERDC	1 (1a)	11	15	165	Moist	0	89	8	0	96.4	72.5	5
USACE-ERDC	1b	38	43	1634	Moist	0	118	9	180	99.0	55	1
USACE-ERDC	2 (2a)	144	10	1440	Moist	0	96	15.5	279	100.0	11.25	0
USACE-ERDC	3	-	-	-	Moist	0	164	17.7	30	96.9	47.5	5
USACE-ERDC	5	25	20.5	512.5	Moist	0	-	-	-	95.1	32.5	2
USACE-ERDC	6	-	-	-	Moist	24	194	11.8	76	99.2	42.5	5
USACE-ERDC	7	-	-	-	Dry Soil	15	110	24.7	202	88.8	42.5	30
USACE-ERDC	8	-	-	-	Moist	19	180	7.6	242	91.2	50	20
USACE-ERDC	9	-	-	-	Dry Soil	0	113	26.2	254	100.0	52.5	30
USACE-ERDC	10											
USACE-ERDC	10a	0.6	0.65	0.39	Moist	0	120	-	-	90.6	65	30
USACE-ERDC	10b	-	-	-	Moist	0	210	11	10	97.1	15	1
USACE-ERDC	11	-	-	-	-	-	-	-	-	-	13.75	<1
USACE-ERDC	12	4	2	8	Dry Soil	0	90	5	318	97.9	60	10
USACE-ERDC	13	49.2	36.1	1776.12	Moist	0	112	15.4	112	99.0	17.5	1

Table A3. Results of USACE ERDC-EL pondberry surveys conducted during September 2020 in the Delta National Forest, Mississippi. Coordinates are generated using the spatial projection NAD83-UTM Zone 15N.

Site	Plot #	Herbivory	Chlorosis	Dieback/ damage	Necrosis	Fungal	Base Freq	Pump Freq	River Gauge	Base Grow	Base Duration	Pump Grow	Pump Duruation
GSRC	1	-	-	-	-	-	5	20	94	<7	<2.5%	<7	<2.5%
GSRC	2	-	-	-	-	-	2	5	91	<7	<2.5%	<7	<2.5%
GSRC	3	-	-	-	-	-	2	5	91	<7	<2.5%	<7	<2.5%
GSRC	4	-1	0	0	0	0	50	0	97	<7	<2.5%	<7	<2.5%
GSRC	5	-	-	-	-	-	20	100	97	<7	<2.5%	<7	<2.5%
GSRC	6	-	-	-	-	-	10	50	95	<7	<2.5%	<7	<2.5%
GSRC	7	-	-	-	-	-	50	0	97	<7	<2.5%	<7	<2.5%
GSRC	8	-	-	-	-	-	50	0	97	<7	<2.5%	<7	<2.5%
GSRC	9	-	-	-	-	-	50	0	97	<7	<2.5%	<7	<2.5%
GSRC	10	0	0	-1	0	0	5	20	93	<7	<2.5%	<7	<2.5%
GSRC	11	-	-	-	-	-	20	100	96	<7	<2.5%	<7	<2.5%
GSRC	12	-	-	-	-	-	10	50	95	<7	<2.5%	<7	<2.5%
GSRC	13	-	-	-	-	-	50	0	97	<7	<2.5%	<7	<2.5%
GSRC	14	-1	0	-1	0	0	5	20	94	<7	<2.5%	<7	<2.5%
GSRC	15	-1	0	-1	0	0	5	10	93	<7	<2.5%	<7	<2.5%
GSRC	16	-1	0	-1	0	0	5	10	93	<7	<2.5%	<7	<2.5%
GSRC	17A	0	0	0	0	0	5	20	94	<7	<2.5%	<7	<2.5%
GSRC	17B	-1	0	0	0	0	5	20	94	<7	<2.5%	<7	<2.5%
GSRC	17C	-1	0	-1	0	0	5	20	94	<7	<2.5%	<7	<2.5%
GSRC	18	-	-	-	-	-	5	10	93	<7	<2.5%	<7	<2.5%
GSRC	19	-	-	-	-	-	5	10	94	<7	<2.5%	<7	<2.5%
GSRC	20	0	0	-1	0	0	5	10	93	<7	<2.5%	<7	<2.5%
GSRC	21	0	-1	-1	0	0	5	10	92	<7	<2.5%	<7	<2.5%
GSRC	22	-	-	-	-	-	50	0	98	<7	<2.5%	<7	<2.5%
GSRC	23	-	-	-	-	-	50	0	98	<7	<2.5%	<7	<2.5%
GSRC	24	-	-	-	-	-	50	0	98	<7	<2.5%	<7	<2.5%

GSRC	25	-	-	-	-	-	50	0	98	<7	<2.5%	<7	<2.5%
GSRC	26	-	-	-	-	-	50	100	97	<7	<2.5%	<7	<2.5%
GSRC	27	-	-	-	-	-	50	0	98	<7	<2.5%	<7	<2.5%
GSRC	28	-	-	-	-	-	20	50	97	<7	<2.5%	<7	<2.5%
GSRC	29	-	-	-	-	-	10	10	95	<7	<2.5%	<7	<2.5%
GSRC	29A	-	-	-	-	-	10	20	96	<7	<2.5%	<7	<2.5%
GSRC	30	-	-	-	-	-	20	50	96	<7	<2.5%	<7	<2.5%
GSRC	31	-	-	-	-	-	20	50	96	<7	<2.5%	<7	<2.5%
GSRC	31A	-1	0	0	0	-1	20	50	96	<7	<2.5%	<7	<2.5%
GSRC	32A	-1	0	-1	-1	0	50	0	97	<7	<2.5%	<7	<2.5%
GSRC	32B	0	0	0	0	0	20	100	96	<7	<2.5%	<7	<2.5%
GSRC	33	-	-	-	-	-	20	100	96	<7	<2.5%	<7	<2.5%
GSRC	34	-	-	-	-	-	20	100	96	<7	<2.5%	<7	<2.5%
GSRC	35	-1	-1	0	0	0	20	100	95	<7	<2.5%	<7	<2.5%
GSRC	36	-1	0	0	0	0	10	20	96	<7	<2.5%	<7	<2.5%
GSRC	37	-	-	-	-	-	20	50	97	<7	<2.5%	<7	<2.5%
GSRC	38	-	-	-	-	-	20	50	97	<7	<2.5%	<7	<2.5%
GSRC	39	-1	0	-1	0	0	10	20	95	<7	<2.5%	<7	<2.5%
GSRC	40	-	-	-	-	-	10	20	95	<7	<2.5%	<7	<2.5%
GSRC	41	-	-	-	-	-	10	20	95	<7	<2.5%	<7	<2.5%
GSRC	42	-1	-1	-1		0	10	20	95	<7	<2.5%	<7	<2.5%
GSRC	43	-1	0	-1	0	0	10	20	95	<7	<2.5%	<7	<2.5%
GSRC	44	-1	0	0	0	0	10	50	94	<7	<2.5%	<7	<2.5%
GSRC	45	-	-	-	-	-	5	10	92	<7	<2.5%	<7	<2.5%
GSRC	46	-	-	-	-	-	5	10	92	<7	<2.5%	<7	<2.5%
GSRC	53	-	-	-	-	-	1	1	91	7-13	2-5%	7-13	2.5-5%
GSRC	54	-1	0	-1		-1	1	1	91	7-13	2-5%	7-13	2.5-5%
GSRC	55	-	-	-	-	-	10	50	96	<7	<2.5%	<7	<2.5%
GSRC	56	-	-	-	-	-	1	1	89	14-20	5-7.5%	14-20	5-7.5%
FS Comp	25	-	-	-	-	-	1	1	91	7-13	2-5%	7-13	2.5-5%
FS Comp	9_1	-1	-1	-1	0	-1	5	10	95	<7	<2.5%	<7	<2.5%
FS Comp	9_2	-1	-1	-1	0	0	5	10	95	<7	<2.5%	<7	<2.5%

McDearman	PL1						10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL2						10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL3						10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL4						10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL5a	0	0	-1	0	-1	10	20	96	<7	<2.5%	<7	<2.5%
McDearman	PL5b	0	-1	-1	0	-1	10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL7	0	0	-1	-1	-1	10	10	95	<7	<2.5%	<7	<2.5%
McDearman	PL8	-1	0	-1	-	0	10	10	95	<7	<2.5%	<7	<2.5%
McDearman	PL9	-1	-1	-1	-	0	10	10	95	<7	<2.5%	<7	<2.5%
McDearman	PL10	-1	-1	-1	-	0	10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL10A	-1	-1	-1	0	0	10	10	95	<7	<2.5%	<7	<2.5%
McDearman	PL10B	-1	0	-1	0	0	10	20	95	<7	<2.5%	<7	<2.5%
McDearman	PL11	-2	0	-1	-1	0	10	20	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	1 (1a)	-1	0	-1	0	0	10	20	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	1b	-1	0	-1	-	0	10	20	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	2 (2a)	0	0	0	0	0	10	10	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	3	-	-	-	-	-	5	10	93	<7	<2.5%	<7	<2.5%
USACE-ERDC	5	-1	0	0	0	0	5	5	93	<7	<2.5%	<7	<2.5%
USACE-ERDC	6	-1	0	-2	0	0	5	10	93	<7	<2.5%	<7	<2.5%
USACE-ERDC	7	-	-	-	-	-	5	20	93	<7	<2.5%	<7	<2.5%
USACE-ERDC	8	0	0	0	-1	0	10	20	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	9	-1	0	-1	0	0	5	20	94	<7	<2.5%	<7	<2.5%
USACE-ERDC	10						10	10	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	10a	-1	0	-1	-1	0	50	0	97	<7	<2.5%	<7	<2.5%
USACE-ERDC	10b	0	0	-1	-	0	5	5	92	<7	<2.5%	<7	<2.5%
USACE-ERDC	11	-	-	-	-	-	10	50	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	12	-1	0	0	0	0	10	20	95	<7	<2.5%	<7	<2.5%
USACE-ERDC	13	-1	-1	-1	-	0	10	10	95	<7	<2.5%	<7	<2.5%

Table A4. Results of USACE ERDC-EL pondberry surveys conducted during September 2020 in the Delta National Forest, Mississippi. Coordinates are generated using the spatial projection NAD83-UTM Zone 15N.			
Site	**Plot #**	**Disturbance**	**Notes**
GSRC	1	Large canopy gap at plot; plot 120 ft from forest edge and ag field	No pondberry
GSRC	2	Canopy gap edge of plot w/ dense understory	No pondberry
GSRC	3	None	No pondberry
GSRC	4	canopy gap in plot with dense understory; no high water mark visible	
GSRC	5	None	No pondberry
GSRC	6	None	No pondberry
GSRC	7	None	No pondberry
GSRC	8	Canopy gap edge of plot with dense understory	No pondberry
GSRC	9	Large tree fall gap at plot center	No pondberry
GSRC	10	Large canopy gap at 1/10 acre plot edge	Single pondberry stem
GSRC	11	Large canopy gap at plot center - dense understory	No pondberry - large canopy gap
GSRC	12	None	No pondberry
GSRC	13	Very large canopy gap at plot center	No pondberry
GSRC	14	55 gal drum	
GSRC	15	Tree fall gap	Two plants had significant herbivory damage. Two plants also had dieback same as USACE04
GSRC	16	Tree fall gap	Two plants had significant herbivory damage. Two plants also had dieback. Same as USACE 04.
GSRC	17A	None. Tree fall ~40 m from plot center	Colony 1 of 3.
GSRC	17B	None	Colony 2 of 3.
GSRC	17C	None	Colony 3 of 3.
GSRC	18	Near river, lots of flood debris on ground	Found plot pole ~25 ft from coordi-tes on ground.
GSRC	19	Canopy gap from 4 dead sassafras trees (~5-10" DBH)	No pondberry. Sweetgum stand w/ sycamore and sassafras s-gs. Lots of vines.
GSRC	20	None	
GSRC	21	None	
GSRC	22	None	No pondberry
GSRC	23	None	No pondberry
GSRC	24	None	No pondberry
GSRC	25	None	No pondberry

GSRC	26	None	No pondberry
GSRC	27	None	No pondberry
GSRC	28	None	No pondberry
GSRC	29	None	No pondberry
GSRC	29A	Feral pigs	No pondberry
GSRC	30	None	Heavy palmetto. No pondberry found
GSRC	31	None	No pondberry found, sites are dry, heavy palmetto understory
GSRC	31A	None	Small colony found 38' from original plot center - Plot Center moved to colony
GSRC	32A	Feral pigs	Colony 1 of 2. ~60% palmetto cover
GSRC	32B	Minor hog damage	Colony 2 of 2. Hog damage very minor. 60% palmetto cover.
GSRC	33	None	No pondberry
GSRC	34	None	Couldn't locate post. Used GPS point. No pondberry found
GSRC	35	Feral pigs	
GSRC	36	Blow down, feral pigs	30% palmetto coverage
GSRC	37	Dead fall, feral pigs	No pondberry. 70% palmetto cover. Lots of deadfall. Heavily disturbed
GSRC	38	Feral pigs	70% palmetto coverage. No pondberry. Saw 3 pigs near site
GSRC	39	Moderate hog activity	Main colony, part of (and center of) 3 distinct clusters/colonies
GSRC	40	Significant hog wallow, current activity	No pondberry
GSRC	41	Some hog damage	No pondberry but near large colonies
GSRC	42	Beaver activity (not recent). 2.5' above ground (when water was up)	~45' from GPS coord.
GSRC	43	Minor hog disturbance	Minor hog disturbance
GSRC	44	None	Found 2 plot poles (PVC) and collected plot data at coordinates. 2 plants occurring at plot center (~8 ft).
GSRC	45	None	No pondberry
GSRC	46	None	No pondberry
GSRC	53	Large limb fell through plot	No pondberry. Supposed GTR but very dry - carpet of oak seedlings
GSRC	54	Small canopy gap - plot dense w/ oak seedlings	
GSRC	55	30 from R-O-W. 3 canopy gap tree falls in or near plot	No pondberry. Pole near plot on edge of row.
GSRC	56	Canopy gap/old road within 15 m	No pondberry - found pipe and recent flagging
FS Comp	25	-	No pondberry. Suspect FSComp25 and GSRC 54 are one in the same. GSCR 54 has pondberry.
FS Comp	9_1	None (Hog wallow 60 m from plot)	Quadrant count.

FS Comp	9_2	None	Counted 10% of stems.
McDearman	PL1		Plots not assessed in detail; 8,000+ stems estimated visually; count combines Points PL1-PL4
McDearman	PL2		Plots not assessed in detail; 8,000+ stems estimated visually; count combines Points PL1-PL4
McDearman	PL3		Plots not assessed in detail; 8,000+ stems estimated visually; count combines Points PL1-PL4
McDearman	PL4		Plots not assessed in detail; 8,000+ stems estimated visually; count combines Points PL1-PL4
McDearman	PL5a	One large canopy gap encrouching on plot. Lots of grass	Several small clumps outside plot, but these were not included.
McDearman	PL5b	Small canopy gap to NW of plot	Found 2 stakes. Others missing? Believe 2 coordi-tes labeled A&D are same location (C was no in GPS)
McDearman	PL7	Few treefall gaps (scattered)	Found 2 orange stakes, estimated 3rd stake location. Plot established in center.
McDearman	PL8	None	Within 25 m of cypress slough. 166 stems
McDearman	PL9	Low to none	224 stems in colony
McDearman	PL10	None	59 Stems
McDearman	PL10A	None	45 plants outside plot at 15S 0713297, 3639693. Waypoint 032. 12 plants clustered at 15S 0713252, 3639636.
McDearman	PL10B	90 stems	90 stems. Measured every other stem.
McDearman	PL11	Scattered palmetto thickets/clumps	Flagged 3 centers. Established plot in center of pondberry and plots.
USACE-ERDC	1 (1a)	None	Snowbell in plot. Thick trumpet creeper in colony.
USACE-ERDC	1b	None	2nd colony in same area USACE 01a, 01b. 65 stems, measured every other stem.
USACE-ERDC	2 (2a)	None	
USACE-ERDC	3	Tree fall	No pondberry. 84 ft to nearest water
USACE-ERDC	4		Pondberry found during July 2020 surveys; subsequently discovered this is actually GSRC16
USACE-ERDC	5	None	
USACE-ERDC	6	None	2 large tree falls to north and south of plot
USACE-ERDC	7	Tree fall	No pondberry
USACE-ERDC	8	Tree fall	Colony 1 of 2. same as USACE 08
USACE-ERDC	9	None	Colony 2 of 2.
USACE-ERDC	10		USACE Plot 10 in July differs by ~18 m from USACe 10a in Sept
USACE-ERDC	10a	Canopy gap on edge of plot	1 live stem - Kevin's original plot, 1 dead. Waypoint saved as P05.
USACE-ERDC	10b	None	Possibly new plot. Near 10a. 27 ft to nearest water.

USACE-ERDC	11	-	
USACE-ERDC	12	None (possible old windthrow)	New Point (originally named Pond 01; renamed USACE-ERDC 12)
USACE-ERDC	13	None	New Colony discovered while doing other nearby fieldwork. Estimated 300 stems. Very tall

Appendix 2

List of attributes and coordinates from ArcGIS shapefile provided to USACE-ERDC in November 2020 for 182 pondberry colonies throughout Delta National Forest

List of attributes and coordinates from ArcGIS shapefiles provided to USACE-ERDC in November 2020 for 182 pondberry colonies throughout Delta National Forest. USACE-ERDC defined a new projection to NAD83 UTM Zone 15N for consistency with other spatial layers with updated coordinates included within table for comparison.

									Spatial Projection:NAD83 UTM Zone 15N		Spatial Projection:NAD1927 UTM Zone 15N		
PBPOINUT_	**PBPOINUT_I**	**SITE**	**SOURCETHM**	**DNF NAME**	**COMPNO**	**ACREAGE**	**DNF_C_MAP**	**DNF_GIS_DA**	**X_COORD**	**Y_COORD**	**X_COORD**	**Y_COORD**	**Col_index**
2	2		pobept.dbf		21	0	N	Y	706998	3633759	707012	3633554.5	1
4	4		pobept.dbf		3	0	Y	Y	714671	3644738	714685	3644533	2
5	5		pobept.dbf		3	0	Y	Y	714681	3644716	714695	3644512	3
6	6		pobept.dbf		3	0	Y	Y	714676.	3644682	714690	3644477	4
7	7		pobept.dbf		3	0	Y	Y	714642	3644650	714657	3644445	5
8	8		pobept.dbf		3	0	Y	Y	714626	3644717	714640	3644512	6
9	9		pobept.dbf		3	0	N	Y	716066	3643451	716080	3643246	7
10	10		pobept.dbf		9	0	N	Y	712597	3641780	712611	3641576	8
11	11		pobept.dbf		9	0	N	Y	712613	3641793	712627	3641588	9
0	0		Dnf_c-maps.shp	01005	1	0	Y	N	717743	3645226	717757	3645021	10
0	0		Dnf_c-maps.shp		4	0	Y	N	714406	3645307	714420	3645103	11
0	0		Dnf_c-maps.shp		4	0	Y	N	714312	3645307	714326	3645103	12
0	0		Dnf_c-maps.shp		4	0	Y	N	714082	3646199	714096	3645995	13
0	0		Dnf_c-maps.shp		4	0	Y	N	713632	3646087	713646	3645882	14
0	0		Dnf_c-maps.shp		5	0	Y	N	711181	3646811	711195	3646606	15
0	0		Dnf_c-maps.shp	06001	6	0	Y	N	710432	3643860	710446	3643655	16
0	0		Dnf_c-maps.shp	08001	8	0	Y	N	714974	3643336	714988	3643131	17
0	0		Dnf_c-maps.shp	08002	8	0	Y	N	714531	3642375	714545	3642171	18
0	0		Dnf_c-maps.shp	08003	8	0	Y	N	716096	3643417	716111	3643212	19
0	0		Dnf_c-maps.shp	09001	9	0	Y	N	712690	3642806	712704	3642601	20
0	0		Dnf_c-maps.shp	09002	9	0	Y	N	712728	3642719	712742	3642514	21
0	0		Dnf_c-maps.shp	09003	9	0	Y	N	712790.7733	3642662	712804	3642458	22
0	0		Dnf_c-maps.shp	09004	9	0	Y	N	712647.2935	3641839	712661	3641634	23
0	0		Dnf_c-maps.shp	09005	9	0	Y	N	712522.5309	3641814	712536	3641609	24
0	0		Dnf_c-maps.shp		17	0	Y	N	711337.2762	3638314.832	711351.3107	3638110.037	25
0	0		Dnf_c-maps.shp		30	0	Y	N	709996.0439	3628601.923	710010.1074	3628397.23	26
0	0		Dnf_c-maps.shp		30	0	Y	N	710245.5779	3630629.343	710259.6336	3630424.631	27
0	0		Dnf_c-maps.shp	3	39	0	Y	N	714621.5918	3625972.952	714635.6954	3625768.226	28
0	0		Dnf_c-maps.shp	47	39	0	Y	N	715181.6042	3627392.721	715195.7072	3627187.974	29
0	0		Corpknow.shp		4	0	Y	N	712510.5966	3646712.586	712524.6081	3646507.701	30
0	0		Corpknow.shp		4	0	Y	N	712507.9325	3646715.611	712521.944	3646510.726	31
0	0		Corpknow.shp		4	0	Y	N	712505.2685	3646718.635	712519.28	3646513.75	32

0	0		Corpknow.shp		4	0	Y	N	714111.8024	3645739.499	714125.8235	3645534.606	33
0	0		Corpknow.shp		4	0	Y	N	712766.336	3645701.098	712780.3521	3645496.219	34
0	0		Corpknow.shp		5	0	N	N	711230.4755	3646663.468	711244.4827	3646458.597	35
0	0		Corpknow.shp		4	0	N	N	712665.7489	3645544.833	712679.7652	3645339.957	36
0	0		Corpknow.shp		16	0	Y	N	713001.3788	3639872.252	713015.4174	3639667.423	37
0	0		Corpknow.shp		21	0	N	N	707152.8711	3633793.961	707166.9332	3633589.229	38
0	0	GSRC 1	All_gsrc.shp		39	0	N	N	715226.0001	3627838	715240.1016	3627633.248	39
0	0	GSRC 2	All_gsrc.shp		39	0	N	N	714942	3626734	714956.1035	3626529.262	40
0	0	GSRC 3	All_gsrc.shp	39	39	0	Y	N	714953.0001	3626621	714967.1041	3626416.263	41
0	0	GSRC 4	All_gsrc.shp		39	0	N	N	715887.8505	3627140.312	715901.9609	3626935.557	42
0	0	GSRC 5	All_gsrc.shp	26	39	0	Y	N	715860.2908	3627066.507	715874.4013	3626861.753	43
0	0	GSRC 6	All_gsrc.shp		39	0	N	N	715872.4138	3627110.218	715886.5242	3626905.463	44
0	0	GSRC 7	All_gsrc.shp	27	39	0	Y	N	715899.4783	3627114.378	715913.5889	3626909.623	45
0	0	GSRC 8	All_gsrc.shp		39	0	N	N	715866.5604	3627009.508	715880.6712	3626804.754	46
0	0	GSRC 9	All_gsrc.shp	38	39	0	Y	N	715923	3627204	715937.1105	3626999.244	47
0	0	GSRC 10	All_gsrc.shp		39	0	N	N	715065.0001	3627535	715079.1014	3627330.253	48
0	0	GSRC 11	All_gsrc.shp	48	39	0	Y	N	715106	3627468	715120.102	3627263.253	49
0	0	GSRC 12	All_gsrc.shp	49	39	0	Y	N	715085.0001	3627536	715099.1016	3627331.253	50
0	0	GSRC 13	All_gsrc.shp		39	0	N	N	715140	3627522	715154.1021	3627317.252	51
0	0	GSRC 14	All_gsrc.shp	35	39	0	Y	N	715889.0001	3627423	715903.1093	3627218.242	52
0	0	GSRC 15	All_gsrc.shp		39	0	N	N	715672.0001	3626615	715686.1108	3626410.252	53
0	0	GSRC 16	All_gsrc.shp		39	0	N	N	715630	3626603	715644.1104	3626398.253	54
0	0	GSRC 17	All_gsrc.shp	22	39	0	Y	N	715607.0001	3626560	715621.1104	3626355.254	55
0	0	GSRC 18	All_gsrc.shp	1	39	0	Y	N	713529	3625978	713543.0933	3625773.29	56
0	0	GSRC 19	All_gsrc.shp	2	39	0	Y	N	713537	3625994	713551.0933	3625789.29	57
0	0	GSRC 20	All_gsrc.shp	54	39	0	Y	N	714552.0001	3626929	714566.0992	3626724.266	58
0	0	GSRC 21	All_gsrc.shp	53	39	0	Y	N	714565	3627002	714579.099	3626797.265	59
0	0	GSRC 22	All_gsrc.shp		2	5.256	N	Y	714102.3929	3646261.046	714116.4119	3646056.149	60
0	0	GSRC 23	All_gsrc.shp		2	5.256	N	Y	714177.8843	3646274.592	714191.9035	3646069.694	61
0	0	GSRC 24	All_gsrc.shp		2	5.256	N	Y	714198.054	3646270.269	714212.0733	3646065.371	62
0	0	GSRC 25	All_gsrc.shp		2	5.256	N	Y	714229.7231	3646267.983	714243.7425	3646063.084	63
0	0	GSRC 26	All_gsrc.shp		4	0	Y	N	713848.3293	3646335.276	713862.347	3646130.381	64
0	0	GSRC 27	All_gsrc.shp	02002	2	0.527	Y	Y	714710.2319	3645913.611	714724.2546	3645708.71	65
0	0	GSRC 28	All_gsrc.shp		4	0	N	N	714417.8001	3645213.266	714431.8246	3645008.374	66
0	0	GSRC 29	All_gsrc.shp		3	0	N	N	714633.9761	3644529.36	714648.0043	3644324.472	67

0	0	GSRC 29A	All_gsrc.shp		3	0	N	N	714669.9719	3644571.889	714684	3644367	68
0	0	GSRC 30	All_gsrc.shp		3	0	N	N	714739.5	3644593.559	714753.5283	3644388.669	69
0	0	GSRC 31	All_gsrc.shp		3	0	N	N	714781.317	3644563.521	714795.3456	3644358.631	70
0	0	GSRC 31A	All_gsrc.shp		3	0	N	N	714774.9796	3644531.839	714789.0084	3644326.949	71
0	0	GSRC 32	All_gsrc.shp		1	0	N	N	717891.999	3645228.823	717906.0372	3645023.894	72
0	0	GSRC 33	All_gsrc.shp		1	0	N	Y	717894.2313	3645241.371	717908.2695	3645036.442	73
0	0	GSRC 34	All_gsrc.shp	01001	1	0	Y	N	717892.1755	3645288.94	717906.2134	3645084.011	74
0	0	GSRC 35	All_gsrc.shp	01002	1	0.692	N	Y	718049.7757	3645425.751	718063.8136	3645220.819	75
0	0	GSRC 36	All_gsrc.shp		7	0	N	N	714155.7256	3642997.696	714169.758	3642792.826	76
0	0	GSRC 37	All_gsrc.shp		7	0	N	N	714260.2364	3642970.795	714274.2694	3642765.924	77
0	0	GSRC 38	All_gsrc.shp		7	0	N	N	714335.3675	3642978.986	714349.4008	3642774.114	78
0	0	GSRC 39	All_gsrc.shp		16	0	Y	N	713317.2267	3640097.724	713331.2662	3639892.889	79
0	0	GSRC 40	All_gsrc.shp		16	0	Y	N	713322.0787	3640082.355	713336.1183	3639877.52	80
0	0	GSRC 41	All_gsrc.shp		16	0	Y	N	713329.5042	3640040.855	713343.544	3639836.02	81
0	0	GSRC 42	All_gsrc.shp		16	0	Y	N	713260.0631	3639977.455	713274.1027	3639772.622	82
0	0	GSRC 43	All_gsrc.shp		16	0	Y	N	713242.5583	3639974.101	713256.5978	3639769.268	83
0	0	GSRC 44	All_gsrc.shp	38001	38	0	Y	N	710727.3799	3624271.285	710741.47	3624066.61	84
0	0	GSRC 45	All_gsrc.shp		47	0	N	N	713152.8514	3621387.716	713167	3621183	85
0	0	GSRC 46	All_gsrc.shp		47	0	N	N	713154.8511	3621369.717	713169	3621165	86
0	0	GSRC 53	All_gsrc.shp	19001	19	1.058	Y	Y	705244.9194	3636408.105	705258.9833	3636203.358	87
0	0	GSRC 54	All_gsrc.shp		25	0	Y	Y	706243.696	3630812.11	706257.7726	3630607.406	88
0	0	GSRC 55	All_gsrc.shp		21	0	N	Y	707042.5067	3633857.986	707056.5692	3633653.254	89
0	0	GSRC 56	All_gsrc.shp		28	0	Y	N	705812.8156	3624981.705	705826.9199	3624777.041	90
0	0		All_gsrc.shp		39	0	N	N	715519.1347	3626791.94	715533.2432	3626587.193	91
0	0		DNF_Comp_Map		1	0	Y	N	718052.7866	3644234.481	718066.8306	3644029.559	92
0	0		DNF_Comp_Map	01003	1	0	Y	N	718360.4671	3645690.031	718374.5048	3645485.094	93
0	0		DNF_Comp_Map	01004	1	0	Y	N	718413.7183	3645713.699	718427.7561	3645508.762	94
0	0		POBEAREA		2	0.583	Y	Y	714946.042	3646495.751	714960.063	3646290.843	95
0	0		DNF_Comp_Map		2	0	Y	N	715705.5048	3646394.263	715719.5291	3646189.348	96
0	0		DNF_Comp_Map	02001	2	0	Y	N	716353.2401	3645661.162	716367.2701	3645456.246	97
0	0		POBEAREA	02004	2	3.327	Y	Y	716001.0836	3645336.54	716015.1138	3645131.631	98
0	0		DNF_Comp_Map		2	0	Y	N	715351.2783	3645852.255	715365.3036	3645647.348	99
0	0		DNF_Comp_Map		3	0	Y	N	714721.9241	3644429.831	714735.953	3644224.943	100
0	0		DNF_Comp_Map		3	0	Y	N	714932.226	3644199.951	714946.2568	3643995.063	101

0	0		DNF_Comp_Map		3	0	Y	N	716070.5748	3644617.792	716084.6086	3644412.888	102
0	0		DNF_Comp_Map		3	0	Y	N	715713.0582	3644231.06	715727.0922	3644026.162	103
0	0		DNF_Comp_Map		3	0	Y	N	715770.3072	3644219.377	715784.3415	3644014.479	104
0	0		DNF_Comp_Map		3	0	Y	N	716054.2165	3644295.323	716068.2517	3644090.422	105
0	0		POBEAREA		4	30.489	Y	Y	713573.1756	3645674.03	713587.1949	3645469.143	106
0	0		DNF_Comp_Map		4	0	Y	N	712202.7074	3645424.837	712216.7224	3645219.967	107
0	0		POBEAREA		4	1.758	Y	Y	711923.9955	3645639.713	711938.0087	3645434.843	108
0	0		POBEAREA		4	3.886	Y	Y	712211.8843	3645662.282	712225.8985	3645457.409	109
0	0		DNF_Comp_Map		4	0	Y	N	714180.9183	3644844.453	714194.9433	3644639.567	110
0	0		DNF_Comp_Map		7	0	Y	N	713612.1303	3642708.125	713626.1613	3642503.263	111
0	0		DNF_Comp_Map		7	0	Y	N	712021.3805	3643530.007	712035.4013	3643325.156	112
0	0		POBEAREA		7	0.664	N	Y	713173.1259	3645449.289	713187.1446	3645244.408	113
0	0		POBEAREA		7	1.413	N	Y	712993.1219	3645263.239	713007.1405	3645058.361	114
0	0		POBEAREA		7	1.004	N	Y	712818.8604	3645051.428	712832.8792	3644846.555	115
0	0		POBEAREA		7	0.492	N	Y	713117.1127	3644849.811	713131.1334	3644644.936	116
0	0		POBEAREA		7	2.651	N	Y	712765.5658	3644878.79	712779.585	3644673.918	117
0	0		POBEAREA		7	1.031	N	Y	712934.7336	3644517.807	712948.7548	3644312.937	118
0	0		POBEAREA	16	15	0.659	Y	Y	710247.9742	3638507.956	710262.0048	3638303.17	119
0	0		DNF_Comp_Map	17	15	0	Y	N	710691.828	3638636.16	710705.8578	3638431.369	120
0	0		DNF_Comp_Map	16001	16	0	Y	N	713277.34	3639721.655	713291.3807	3639516.823	121
0	0		DNF_Comp_Map	16002	16	0	Y	N	713575.1471	3639975.348	713589.1884	3639770.511	122
0	0		DNF_Comp_Map	16003	16	0	Y	N	713834.3492	3640085.652	713848.3915	3639880.811	123
0	0		DNF_Comp_Map	16004	16	0	Y	N	713007.1085	3639732.681	713021.1477	3639527.853	124
0	0		DNF_Comp_Map	16005	16	0	Y	N	712858.2055	3639732.68	712872.2438	3639527.853	125
0	0		DNF_Comp_Map	16006	16	0	Y	N	712808.5718	3639920.189	712822.6092	3639715.362	126
0	0		DNF_Comp_Map	16007	16	0	Y	N	713073.2887	3640019.463	713087.3272	3639814.631	127
0	0		DNF_Comp_Map		17	0	Y	N	710892.3447	3638308.766	710906.3766	3638103.976	128
0	0		DNF_Comp_Map		17	0	Y	N	711341.0938	3638264.872	711355.1284	3638060.077	129
0	0		POBEAREA		17	1.045	Y	N	710560.1752	3638118.963	710574.2058	3637914.179	130
0	0		POBEAREA		30	1.298	Y	Y	710176.6234	3629236.513	710190.6839	3629031.814	131
0	0		DNF_Comp_Map		30	0	Y	N	710655.207	3629686.718	710669.2635	3629482.014	132
0	0		DNF_Comp_Map	47001	47	0	Y	N	713282.8679	3621053.658	713297.0219	3620848.939	133
0	0		DNF_Comp_Map	47002	47	0	Y	N	713239.9368	3621067.014	713254.0904	3620862.296	134
0	0		DNF_Comp_Map	47003	47	0	Y	N	713279.0522	3621087.05	713293.2058	3620882.331	135
0	0		DNF_Comp_Map	48001	48	0	Y	N	706391.3118	3618628.685	706405.491	3618423.995	136

0	0		DNF_Comp_Map		56	0	Y	N	716675.1727	3618695.718	716689.3833	3618490.954	137
0	0		DNF_Comp_Map		57	0	Y	N	716869.8192	3618759.072	716884.0305	3618554.306	138
0	0		DNF_Comp_Map		57	0	Y	N	716842.2762	3618860.068	716856.4861	3618655.302	139
0	0		DNF_Comp_Map		57	0	Y	N	716938.6816	3618908.731	716952.8916	3618703.964	140
0	0		DNF_Comp_Map		57	0	Y	N	717054.3684	3619000.547	717068.5782	3618795.779	141
0	0		DNF_Comp_MAP	4	39	0	Y	N	714767.4827	3626169.16	714781.5868	3625964.43	142
0	0		DNF_Comp_Map	5	39	0	Y	N	714705.4617	3626315.439	714719.5647	3626110.708	143
0	0		DNF_Comp_Map	6	39	0	Y	N	714802.5899	3626334.164	714816.6937	3626129.432	144
0	0		DNF_Comp_Map	7	39	0	Y	N	714840.037	3626347.038	714854.1411	3626142.305	145
0	0		DNF_Comp_Map	8	39	0	Y	N	714890.356	3626261.611	714904.4609	3626056.878	146
0	0		DNF_Comp_Map	9	39	0	Y	N	715091.6338	3626321.296	715105.7404	3626116.56	147
0	0		DNF_Comp_Map	10	39	0	Y	N	715127.9106	3626304.913	715142.0175	3626100.176	148
0	0		DNF_Comp_Map	11	39	0	Y	N	715085.783	3626383.319	715099.8892	3626178.582	149
0	0		DNF_Comp_Map	12	39	0	Y	N	715092.8046	3626443.001	715106.9106	3626238.263	150
0	0		DNF_Comp_Map	13	39	0	Y	N	715153.6562	3626514.387	715167.7626	3626309.647	151
0	0		DNF_Comp_Map	40	39	0	Y	N	715068.2308	3626646.622	715082.3358	3626441.883	152
0	0		DNF_Comp_Map	46	39	0	Y		715210.9992	3627062.06	715225.1038	3626857.315	153
0	0		DNF_Comp_Map	41	39	0	Y	N	714968.763	3626844.391	714982.8663	3626639.652	154
0	0		DNF_Comp_Map	42	39	0	Y	N	715005.0398	3626856.094	715019.1434	3626651.354	155
0	0		DNF_Comp_Map	43	39	0	Y	N	714992.1676	3626902.904	715006.2709	3626698.164	156
0	0		DNF_Comp_Map	44	39	0	Y	N	715013.2318	3626950.884	715027.335	3626746.143	157
0	0		DNF_Comp_Map	45	39	0	Y	N	715060.0405	3626948.544	715074.1442	3626743.803	158
0	0		DNF_Comp_Map	14	39	0	Y	N	715397.0604	3626197.255	715411.1703	3625992.515	159
0	0		DNF_Comp_Map	15	39	0	Y	N	715725.8927	3626421.946	715740.0048	3626217.199	160
0	0		DNF_Comp_Map	16	39	0	Y	N	715810.1491	3626560.036	715824.2613	3626355.286	161
0	0		DNF_Comp_Map	17	39	0	Y	N	715874.5109	3626528.44	715888.6239	3626323.69	162
0	0		DNF_Comp_Map	18	39	0	Y	N	715557.3819	3626570.564	715571.4917	3626365.818	163
0	0		DNF_Comp_Map	20	39	0	Y	N	715509.4027	3626521.413	715523.5123	3626316.669	164
0	0		DNF_Comp_Map	21	39	0	Y	N	715536.3177	3626507.371	715550.4276	3626302.626	165
0	0		DNF_Comp_Map	19	39	0	Y	N	715517.5944	3626561.202	715531.7039	3626356.457	166
0	0		All_gsrc.shp		39	0	N	N	715231.2737	3627734.289	715245.3757	3627529.538	167
0	0		DNF_Comp_Map	50	39	0	Y	N	715054.6985	3627568.834	715068.7996	3627364.087	168
0	0		DNF_Comp_Map	51	39	0	Y	N	715098.3166	3627591.483	715112.418	3627386.735	169
0	0		DNF_Comp_Map	52	39	0	Y	N	715090.7677	3627683.753	715104.8687	3627479.005	170
0	0		DNF_Comp_Map	36	39	0	Y	N	715892.7775	3627357.352	715906.8871	3627152.594	171

0	0		DNF_Comp_Map	37	39	0	Y	N	715935.3728	3627254.138	715949.4831	3627049.381	172
0	0		DNF_Comp_Map	29	39	0	Y	N	716010.7339	3627160.755	716024.8454	3626955.997	173
0	0		DNF_Comp_Map	34	39	0	Y	N	716025.4796	3627390.12	716039.5902	3627185.361	174
0	0		DNF_Comp_Map	33	39	0	Y	N	716032.0326	3627355.716	716046.1434	3627150.956	175
0	0		DNF_Comp_Map	32	39	0	Y	N	716151.6283	3627372.101	716165.7401	3627167.339	176
0	0		DNF_Comp_Map	31	39	0	Y	N	716020.5642	3627281.991	716034.6753	3627077.232	177
0	0		DNF_Comp_Map	30	39	0	Y	N	716018.9257	3627224.649	716033.037	3627019.891	178
0	0		DNF_Comp_Map	28	39	0	Y	N	716012.3721	3627134.541	716026.4837	3626929.784	179
0	0		DNF_Comp_Map	25	39	0	Y	N	716094.2866	3627064.095	716108.3992	3626859.337	180
0	0		DNF_Comp_Map	24	39	0	Y	N	716195.861	3627091.948	716209.9745	3626887.188	181
0	0		DNF_Comp_Map	23	39	0	Y	N	716190.9458	3627023.138	716205.0595	3626818.379	182

Appendix 3

Coordinates for plot corners for the McDearman pondberry surveys (1990's)

Coordinates for plot corners for the McDearman pondberry surveys. The X and Y projections are in NAD83 UTM Zone 15N.									
TYPE	**IDENT**	**LAT**	**LONG**	**X PROJ**	**Y PROJ**	**ALTITUDE**	**TIME**	**MODEL**	**LTIME**
WAYPOINT	PL1	32.877453	-90.720623	713247.624	3640004.207	37.88	2011-12-14T15:57:43Z	GPSMAP 62s	2011/12/14 09:57:43
WAYPOINT	PL2	32.877218	-90.7205	713259.6968	3639978.396	38.96	2011-12-14T16:03:06Z	GPSMAP 62s	2011/12/14 10:03:06
WAYPOINT	PL3	32.877308	-90.720089	713297.9407	3639989.207	37.99	2011-12-14T16:07:04Z	GPSMAP 62s	2011/12/14 10:07:04
WAYPOINT	PL4	32.877114	-90.720834	713228.6918	3639966.187	37.08	2011-12-14T16:13:51Z	GPSMAP 62s	2011/12/14 10:13:51
WAYPOINT	PL4B	32.877223	-90.720772	713234.2323	3639978.4	36.98	2011-12-14T16:16:12Z	GPSMAP 62s	2011/12/14 10:16:12
WAYPOINT	PL5A	32.874479	-90.723648	712971.6749	3639668.296	35.96	2011-12-14T17:02:56Z	GPSMAP 62s	2011/12/14 11:02:56
WAYPOINT	PL5B	32.874522	-90.723745	712962.4949	3639672.868	36.25	2011-12-14T17:03:50Z	GPSMAP 62s	2011/12/14 11:03:50
WAYPOINT	PL5C	32.874395	-90.723948	712943.8023	3639658.375	36.01	2011-12-14T17:05:43Z	GPSMAP 62s	2011/12/14 11:05:43
WAYPOINT	PL5D	32.874396	-90.723756	712961.767	3639658.874	35.66	2011-12-14T17:06:22Z	GPSMAP 62s	2011/12/14 11:06:22
WAYPOINT	PL6A	32.87425	-90.723565	712979.9898	3639643.069	35.73	2011-12-14T17:08:03Z	GPSMAP 62s	2011/12/14 11:08:03
WAYPOINT	PL6B	32.874189	-90.723593	712977.5156	3639636.248	35.23	2011-12-14T17:08:33Z	GPSMAP 62s	2011/12/14 11:08:33
WAYPOINT	PL6C	32.874189	-90.723592	712977.6092	3639636.25	35.43	2011-12-14T17:09:08Z	GPSMAP 62s	2011/12/14 11:09:08
WAYPOINT	PL6D	32.874246	-90.723544	712981.9646	3639642.667	35.19	2011-12-14T17:09:41Z	GPSMAP 62s	2011/12/14 11:09:41
WAYPOINT	PL7A	32.87454	-90.724555	712886.6534	3639673.229	36.36	2011-12-14T17:14:59Z	GPSMAP 62s	2011/12/14 11:14:59
WAYPOINT	PL7B	32.874636	-90.724535	712888.2953	3639683.916	36.37	2011-12-14T17:15:37Z	GPSMAP 62s	2011/12/14 11:15:37
WAYPOINT	PL7C	32.874555	-90.724682	712874.733	3639674.636	36.39	2011-12-14T17:17:28Z	GPSMAP 62s	2011/12/14 11:17:28
WAYPOINT	PL8A	32.874429	-90.72218	713109.1677	3639665.716	34.21	2011-12-14T17:44:49Z	GPSMAP 62s	2011/12/14 11:44:49
WAYPOINT	PL9A	32.874828	-90.721665	713156.4051	3639711.004	36.47	2011-12-14T18:37:16Z	GPSMAP 62s	2011/12/14 12:37:16
WAYPOINT	PL9B	32.874794	-90.721621	713160.604	3639707.322	35.1	2011-12-14T18:38:09Z	GPSMAP 62s	2011/12/14 12:38:09
WAYPOINT	PL9C	32.874745	-90.721745	713149.1177	3639701.638	34.39	2011-12-14T18:39:22Z	GPSMAP 62s	2011/12/14 12:39:22
WAYPOINT	PL10A	32.874174	-90.720503	713266.71	3639640.828	36.02	2011-12-14T18:52:41Z	GPSMAP 62s	2011/12/14 12:52:41
WAYPOINT	PL10B	32.874201	-90.720554	713261.8727	3639643.719	36.9	2011-12-14T18:53:29Z	GPSMAP 62s	2011/12/14 12:53:29
WAYPOINT	PL10C	32.874319	-90.720544	713262.5258	3639656.824	37.56	2011-12-14T18:54:57Z	GPSMAP 62s	2011/12/14 12:54:57
WAYPOINT	PL10D	32.874359	-90.720545	713262.3364	3639661.258	36.92	2011-12-14T18:55:39Z	GPSMAP 62s	2011/12/14 12:55:39
WAYPOINT	PL10E	32.874388	-90.72047	713269.2853	3639664.626	37.52	2011-12-14T18:56:09Z	GPSMAP 62s	2011/12/14 12:56:09
WAYPOINT	PL10F	32.874353	-90.720454	713270.8664	3639660.777	37.3	2011-12-14T18:56:45Z	GPSMAP 62s	2011/12/14 12:56:45
WAYPOINT	PL11A	32.873963	-90.724393	712903.1932	3639609.57	32.01	2011-12-14T19:43:19Z	GPSMAP 62s	2011/12/14 13:43:19
WAYPOINT	PL11B	32.874036	-90.724549	712888.4203	3639617.351	33.59	2011-12-14T19:46:02Z	GPSMAP 62s	2011/12/14 13:46:02
WAYPOINT	PL11C	32.873903	-90.724483	712894.9146	3639602.735	34.32	2011-12-14T19:47:07Z	GPSMAP 62s	2011/12/14 13:47:07
WAYPOINT	GSRC42	32.877331	-90.720349	713273.556	3639991.232	34.37	2011-12-14T20:07:28Z	GPSMAP 62s	2011/12/14 14:07:28

Appendix 4

Location and Images of New pondberry Colonies Located in 2020

PB01 (GSRC 26) N 32.9325442° W 90.712631°; Areas of dense *Sabal minor*, a few dead canopy trees, groundcover sparse.

PB02 (GSRC 22) N 32.9318254° W 90.709933°; Areas of dense *Sabal minor*, groundcover sparse.

USACE01 — N 32.875853° W 90.719897° (All colony assessment photos are N/E/S/W starting clockwise from top left)

USACE2A — N 32.875062° W 90.720407°

USACE2B — N 32.875116° W 90.720381°

USACE03 — N 32.756118° W 90.698417°

USACE04 — N 32.756247° W 90.698343°

USACE05 — N 32.759556° W 90.693558°

USACE06 — N 32.754489° W 90.700256°

USACE07 — N 32.754554° W 90.700126°

USACE08 — N 32.755293° W 90.699116°

USACE09 — N 32.755489° W 90.698913°

USACE10 — N 32.761037° W 90.704588°

USACE11 — N 32.762498° W 90.694088° (15 N 716008, 3627310)

INFORMAL CONSULTATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mississippi Ecological Services Field Office
6578 Dogwood View Parkway, Suite A
Jackson, Mississippi 39213
Phone: (601)965-4900 Fax: (601)965-4340

November 5, 2020

IN REPLY REFER TO:
2021-I-0076

Ms. Sara Thames
Regional Planning and Environmental Division South
U.S. Army Corps of Engineers
4155 East Clay Street
Vicksburg, Mississippi 39180

Dear Ms. Thames:

The Fish and Wildlife Service (Service) has reviewed your correspondence (i.e. biological assessment) dated September 30, 2020, regarding the proposed Yazoo Area Pump Project. Your office is currently preparing a supplemental environmental impact statement titled "Draft Supplement No. 2 to the 2007 Final Supplement No. 1 to the 1982 Yazoo Area Pump Project". Our comments are submitted in accordance with the Endangered Species Act (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

The Yazoo Study Area is located in west-central Mississippi immediately north of Vicksburg, Mississippi, and includes all or portions of Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo counties, Mississippi, and part of Madison Parish, Louisiana. The proposed project includes the construction of a pumping plant and associated infrastructure, potential reforestation of agricultural lands primarily below 87.0 feet, National Geodetic Vertical Datum, along with mitigation features including supplemental low flow ground water wells, and acquisition/reforestation of 2,400 acres of frequently flooded agricultural lands.

Your office determined that 11 federally protected or "proposed for listing" species could be found within the Yazoo Study Area. Based on information provided in your biological assessment, you determined that the proposed project "may affect, but is not likely to adversely affect" (MANLAA) 10 of these species. Provided below is a short analysis of effects to each species along with our concurrence with your determination. Also, ESA consultation for the federally endangered pondberry will occur separately since sufficient data is not available at this time to make an "effects" determination.

Eastern Black Rail - The final rule to list the eastern black rail as threatened was published on October 8, 2020. Eastern black rails can be found year round within the coastal marshes and

associated habitat throughout southeastern coastal States (i.e. AL, MS, LA, and TX). The history of eastern black rails in the interior continental United States is poorly known and they are currently considered vagrants (casual or accidental) in states such as Arkansas, Illinois, and Missouri. Although we anticipate the Yazoo Area Pump Project may result in changes to the structure of native vegetation within the project area (e.g. conversion from emergent to scrub-shrub wetlands, wetland into upland habitat, etc.), there is little supporting data to suggest black rails are using the project area beyond short term foraging associated with migration between prairie and coastal marsh habitats. Therefore, any impact associated with wetland loss/habitat conversion is expected to be insignificant and not rise to the level of take. Therefore, we concur with your determination of MANLAA for the eastern black rail.

Fat Pocketbook - Within Mississippi, the endangered fat pocketbook mussel can be found in the Mississippi River, particularly secondary channels and chutes. A single historical record exists within the Yazoo Study Area, specifically the Big Sunflower River in Sharkey County, Mississippi. The 2019 five-year review for the fat pocketbook recommended delisting due to recovery.

Based upon extensive survey efforts over the past few decades, as well as current low flow and hypoxic conditions, it is most likely that the fat pocketbook is extirpated from the Yazoo Study Area. Therefore, we concur with your determination of MANLAA for the fat pocketbook.

Interior Least Tern - The federally endangered Interior least tern breeding range includes most major river systems in the central United States, including the Lower Mississippi River adjacent to the Yazoo Study Area. No nesting within the Yazoo Study Area has been recorded, and only a few observations of feeding or pass-through birds. In 2019, the Service proposed to remove this species from the Federal List of Endangered and Threatened Species due to recovery.

Based on the fact that the proposed project will not impact potential nesting habitat along the Mississippi River, and that very few observations of Interior least terns have been made within the Yazoo Study Area, we concur with your determination of MANLAA for the Interior least tern. We anticipate the effects of the action on Interior least terns to be insignificant.

Northern Long-eared Bat - The Northern long-eared bat (NLEB) was listed as threatened on May 4, 2015. A final 4(d) rule was published in 2016 exempting incidental take of otherwise legal actions related to tree clearing, except when tree removal occurs within a hibernacula site or when tree removal activities: 1) occur within a quarter-mile of a known hibernacula; or 2) cut or destroy known occupied maternity roost trees, or any other trees within 150 feet of that maternity roost tree during the pup-rearing season (June 1–July 31). Currently, there are no known maternity roost trees in the state of Mississippi and one known hibernaculum located in Tishomingo County near Pickwick Lake.

Included in your Biological Assessment is a completed NLEB 4(d) Rule Streamlined Consultation Form outlining potential tree clearing that will occur as a result of the proposed project. Completion of this form allows your agency to rely upon the Service's January 5, 2016, intra-Service Programmatic Biological Opinion on the final 4(d) rule for the NLEB. Therefore,

the Service concurs that this project may affect the NLEB, but that any resulting incidental take of the NLEB is not prohibited by the final 4(d) rule.

Pallid Sturgeon - Within Mississippi, the federally endangered pallid sturgeon occurs primarily within the mainstem of the Mississippi River. There is a single historical record from the Big Sunflower River, however, no recent records of the pallid sturgeon have been reported within the Yazoo Study Area.

Current conditions within the Yazoo Study Area include diminished minimum flows and seasonal hypoxia, which are not favorable for the presence of pallid or shovelnose sturgeon. In addition, the riverine habitat within the project area is not conducive to spawning or larval recruitment for any sturgeon species. Therefore, we concur with your determination of MANLAA for the pallid sturgeon.

Piping Plover - There are three distinct populations of piping plovers, with birds breeding during the summer months along the Atlantic Coast, Great Lakes, or within the river systems in the Great Plains. Birds from all populations migrate to the Atlantic and Gulf Coasts of the southeastern United States, and south to Mexico and Central America for the winter months. Data suggests that piping plovers found within the action area primarily use the sandbars and mudflats along the Mississippi River for foraging during the migration season only, and few records exist for plovers within the Yazoo Study Area.

Since the proposed project will not impact Mississippi River sandbars and adjacent mud flats, and birds are only present in the action area during migration, we anticipate the effects of the proposed project on piping plovers to be insignificant. Therefore, we concur with your determination of MANLAA for the piping plover.

Rabbitsfoot Mussel - Within Mississippi, the federally threatened rabbitsfoot mussel occurs in the Tennessee, Yazoo and Big Black River drainages. Within the Yazoo drainage, the species can be found in the Big Sunflower River, and a 32 mile reach of the river between Indianola and Ruleville (Sunflower County, Mississippi) is designated as critical habitat. No extant populations are currently known within the Yazoo Study Area.

The proposed supplemental stream flows within the basin during current low flow situations may improve conditions and survivability of native mussels, therefore, the proposed project could result in beneficial effects to this species. Therefore, we concur with your determination of MANLAA for the rabbitsfoot mussel.

Red Knot - There are two red knot subspecies in the conterminous United States. The eastern population (*Calidris canutus rufa*) breeds in the artic and winters along the Gulf of Mexico. Migrating red knots may use sandbars and adjacent mud flats along the Mississippi River during spring and fall migration. Since the proposed project will not impact Mississippi River sandbars and adjacent mud flats, and birds are only present in the action area during migration, we anticipate the effects of the proposed project on red knots to be insignificant. Therefore, we concur with your determination of MANLAA for the red knot.

Sheepnose Mussel - Within Mississippi, the federally endangered sheepnose mussel can be found in the Yazoo and Big Black River drainages. Within the Yazoo drainage, the species can be found in the Big Sunflower River between Indianola and Ruleville in Sunflower County, Mississippi. No extant populations are currently known within the Yazoo Study Area.

The proposed supplemental stream flows within the basin during current low flow situations may improve conditions and survivability of native mussels, therefore, the proposed project could result in beneficial effects to this species. Therefore, we concur with your determination of MANLAA for the sheepnose mussel.

Wood Stork - Two distinct populations of wood storks occur in the United States. One population breeds in Florida, Georgia, and South Carolina (i.e. Eastern population), and is federally protected (threatened). The other population breeds from Mexico to northern Argentina (i.e. Western population) and is not federally protected by the ESA. Wood storks from each of these populations occur seasonally in Mississippi during the non-breeding season (May-October) and are not distinguishable from one another. Data from studies following satellite tagged wood storks from the eastern population indicate very few birds migrate into western Mississippi (i.e. Yazoo Study Area) and that most, if not all, wood storks observed in the study area are from the non-listed western population. Given the low likelihood of the threatened population to occur in the Yazoo Study Area, we anticipate the effects of the proposed project on wood storks to be insignificant. Therefore, we concur your determination of MANLAA for the wood stork.

No further consultation with this office is required for these species unless there are changes in the scope or location of the proposed project, or if any federally listed species are discovered during construction. If the proposed project has not been initiated within one year of this letter, follow-up consultation should be initiated with the Service.

If you have any questions, please contact David Felder in our office, telephone: (601) 321-1131, email: david_felder@fws.gov.

Sincerely,

Stephen Ricks

Stephen M. Ricks
Field Supervisor
Mississippi Field Office

ESA MEMO

To: Stephen Ricks, USFWS
Field Supervisor
U.S. Fish and Wildlife Service
Mississippi Ecological Services Field Office
6578 Dogwood View Parkway
Jackson, Mississippi 39213

From: Sara Thames
Date: September 30, 2020

Subject: ESA coordination for Draft Supplement No. 2 to the 1982 Yazoo Area Pump Project Final Environmental Impact Statement

Dear Mr. Ricks:

Attention: David Felder

The U.S. Army Corps of Engineers (USACE), Vicksburg District (MVK), is preparing a draft supplemental environmental impact statement titled "Draft Supplement No. 2 to the 2007 Final Supplement No. 1 to the 1982 Yazoo Area Pump Project" and is requesting concurrence with our threatened and endangered species determination of **"May affect, not likely to adversely affect"** for **Piping Plover, Red Knot, Wood Stork, Least Tern, Eastern Black Rail, Northern Long-eared Bat, Pallid Sturgeon, Fat Pocketbook, Rabbitsfoot, and Sheepnose**. Coordination on the pondberry will take place separately as sufficient data is not available at this time to make a determination.

Study Area

The Yazoo Study Area (Figure 1) is located in west-central Mississippi immediately north of Vicksburg, Mississippi, and has historically been subject to flooding from backwater by the Mississippi River and headwater flooding from the Yazoo River, Sunflower River, and Steele Bayou. The triangular shaped study area extends northward about 65 miles to the latitude of Hollandale and Belzoni, Mississippi, and comprises about 1,446 square miles. Big Sunflower and Little Sunflower rivers, Deer Creek, and Steele Bayou flow through the Yazoo Study Area.

The Yazoo Study Area contains approximately 926,000 acres of which approximately 500,000 acres are lands within the 100-year flood frequency. The Yazoo Study Area is bordered by the left descending bank of the mainline Mississippi River levee on the west, the west bank levees of the Whittington Auxiliary Channel and the Yazoo River on the east, and the Yazoo Backwater Levee on the south (Figure 2). The Yazoo Study Area includes all or portions of Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo counties, Mississippi and part of Madison Parish, Louisiana.

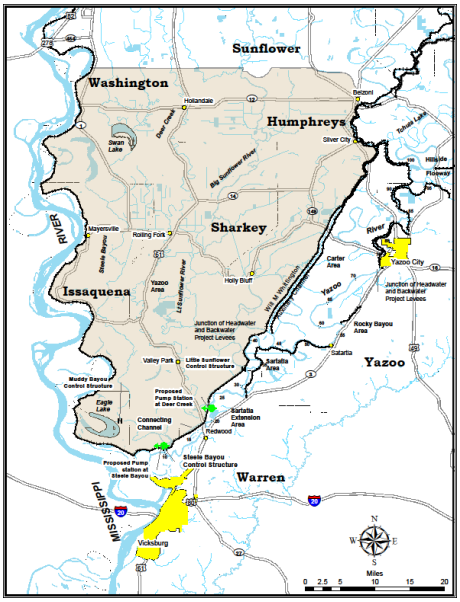

Figure 1 Yazoo Study Area.

Figure 2 Yazoo Study Area.

The pump station will be located in Warren County, Mississippi, approximately eight miles northeast of the Steele Bayou water control structure near Deer Creek, between the Yazoo Backwater levee and the Yazoo River, and approximately three miles northeast of the intersection of Highway 465 and Highway 61. A borrow area will be located north of Highway 465 and the Yazoo Backwater levee, approximately eight miles southwest of the pump station, and approximately 0.5 mile northwest of the Steele Bayou water control structure. Thirty-four supplemental low flow groundwater wells will be located north of the Yazoo Study Area, in Washington, Bolivar, and Coahoma counties, Mississippi, and within the project drainage area. The supplemental low flow groundwater wells will be installed adjacent to the Mississippi River levee on the landside, upstream of the backwater area, in areas primarily utilized for agricultural production, and adjacent to headwater streams.

Proposed Plan

The Proposed Plan represents a balanced approach to addressing the flood damage reduction and environmental opportunities in the Yazoo Study Area. The Proposed Plan includes structural and nonstructural features as discussed below.

Structural feature:

- A 14,000 cfs pump station, located near Deer Creek, consisting of twelve pumps, with year-round pump-on activation at water stage elevation 87.0ft, NGVD, when the riverside water elevation is greater than the landside water elevation at the Steele Bayou water control structure.
- Current operation of the Steele Bayou water control structure within the Yazoo Study Area will remain the same, maintaining the water levels in the Yazoo Study Area between 68.5 and 70.0 feet, NGVD, during low flow periods.
- The pump station would be operated according to a pump station operation manual. The pumps will be natural gas driven pumps and could not be instantaneously turned on all at the same time. Nor would all the pumps be utilized every time stages were predicted to

exceed elevation 87.0 feet, NGVD. Consequently, by varying the number of pumps which are activated at a given time, several scenarios can be tested as part of the adaptive operational management process. Other factors that would have to be accounted for would be the forecast of inflows due to Mississippi River conditions, interior conditions (stages and ground conditions) and forecasted flood and weather conditions. The availability of natural gas as the power sources will help reduce the carbon footprint of operating the pump station and the initial capital cost of the project.

Nonstructural feature:

- Acquisition and reforestation/conservation features on up to 2,700 acres of agricultural lands through perpetual easements from willing sellers only. Approximately 2,100 acres of cleared land are potentially available below elevation 87.0 feet, NGVD, and the remaining acreage needed to reach up to the 2,700 acres will be acquired at or near 87.0 feet, NGVD. Securing this conservation feature on lands below elevation 87 feet, NGVD, will remove these lands from future economic damages resulting from flooding. Up to 10 percent of an acquired property could be in conservation features other than reforestation. Conservation features are practices implemented and maintained solely for wildlife management purposes. Conservation features include, but are not necessarily limited to (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year floodplain elevation). While the MVK will provide the pipe for the waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches. The location of these lands are unknown at this time. Nonstructural reforestation parcels likely differ from compensatory mitigation lands in several ways (e.g. smaller than the large parcels targeted for compensatory mitigation, may lack contiguous forested boundaries).

Mitigation features:

- Installation of 34 supplemental low flow groundwater wells adjacent to the Mississippi River levee and upstream of the Yazoo Study Area which would supply up to 5 cfs per well during low flow periods.
- Acquisition of 2,405 acres of frequently flooded agricultural lands in fee title and subsequent reforestation of these lands will be pursued to offset any unavoidable losses to wetlands, terrestrial, and waterfowl resources.

Proposed Plan Detailed Project Description

Pump Station/Inlet Channel/Outlet Channel/Access Road/Utilities

The pump station will be located in Warren County, Mississippi, approximately eight miles northeast of the Steele Bayou water control structure near Deer Creek, between the Yazoo Backwater levee and the Yazoo River, and approximately three miles northeast of the intersection of Highway 465 and Highway 61. The pump station right-of-way will be

approximately 211.76 acres. Construction of the pump station, inlet channel, outlet channel, new levee associated with the pump station, along with removal of part of the existing levee for construction of the inlet channel and subsequent construction of a bridge over the inlet channel to connect the existing levee, will take place within the pump station right-of-way. Figure 4 shows a three dimensional model view of the completed pump station and associated features. Figure 5 shows the pump station, access road, and utilities right-of-ways.

The pump station will be constructed of reinforced concrete and will consist of wing walls, flood walls, retaining walls, intake structures, pump bay monoliths, a control room monolith, and a service bay monolith. Construction and permanent access to the new pump station will be accessed by traveling northeast on the existing Yazoo Backwater levee for approximately 2.3 miles from Highway 61. The existing Yazoo Backwater levee road will need to be widen to accommodate traffic, which will require the crown of the levee to be widened. The right-of-way for the access road and subsequent levee widening will be approximately 25.07 acres. The access road will enter the restricted facility by way of the new levee. The new levee and pump station are joined and tie into the existing backwater levee. The crown of the levees will be paved with asphalt to provide a smooth surface course. Utilities will be run parallel and approximately 80 feet to the southeast of the pump station access road. The utilities line right-of-way will be approximately 50 feet wide and approximately 10.54 acres. Utilities (both natural gas and electricity) are readily available and in close proximity to the pump station.

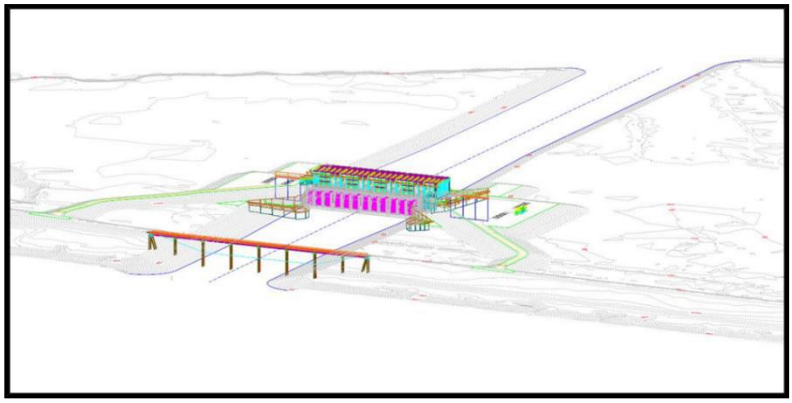

Figure 4 Three dimensional model view of the pump station and associated features.

Figure 5 Pump station (32.54016/-90.79869), access road, and utilities right-of-ways.

An inlet channel will be constructed to connect the pump station to the existing connecting channel. The inlet channel will be approximately 1,200 feet long and will require the excavation of approximately 500,000 cubic yards of material. The inlet channel will be lined with riprap and filter stone. An outlet channel will connect the pump station to the Yazoo River. The outlet channel will be approximately 1,800 feet long and will require the excavation of approximately 475,000 cubic yards of material. The outlet channel will be lined with riprap and filter stone. The inlet and outlet channel will form a secondary means of transferring floodwaters from the Yazoo Study Area into the Yazoo River via the pump station to reduce the damages resulting from Mississippi River backwater flooding.

Impervious material taken from the channel and structural excavation, if found suitable, will be used in construction of the new cofferdam and new levee and for structural backfill. If a shortage of impervious material from the channel and structural excavation occurs, borrow material will be hauled on-site from the borrow area location. The new levee will be constructed to finish grade elevation of 112 feet, NGVD, with 1 on 4 side slopes. A bridge will be constructed across the inlet channel to connect the existing Yazoo Backwater levee for continued public use, however access to the new pump station will be restricted. The new bridge will be pile founded and approximately 700 feet long. Construction will require the use of a cofferdam that will be at an elevation of 112 feet, NGVD, and will have 1 on 4 side slopes. The cofferdam will require approximately 105,000 cubic yards of borrow material for construction. Construction will require a preload at the site which will have a crown elevation of 125 feet, NGVD, and a berm at elevation 107 feet, NGVD, which will be 690 feet wide and 450 feet long. The preload will be removed prior to construction and the cofferdam will be removed upon completion of construction. All excess and/or unused material removed for construction will be taken to a government approved disposal area or stockpiled for possible future use. All construction activities associated with constructing the new pump station will adhere to federal, state, and local laws.

Borrow Area

The borrow area is located north of Highway 465 and north of the Yazoo Backwater levee, approximately eight miles southwest of the pump station, and approximately 0.5 mile northwest of the Steele Bayou water control structure. The borrow area right-of-way is approximately 35.92 acres. An access road will be constructed to access the borrow area from Highway 465. From Highway 465, approximately 0.1 mile of site work will be required in order to construct an access road to tie into an existing coffer dam. The access road will be constructed on the coffer dam and continue for approximately 0.25 mile and intersect with the existing Yazoo Backwater levee road. The access road will then continue west along the Yazoo Backwater levee road for approximately 0.2 mile. From the Yazoo Backwater levee road, the access road construction will turn north for approximately 0.15 mile to the borrow area. The borrow area access road right-of-way is approximately 9.74 acres. Figure 6 shows the borrow area and access road right-of-ways.

If suitable, the material from the excavation of the inlet and outlet channels and corresponding cofferdam will be used to construct the new levee and cofferdam. If the excavated material is deemed unsuitable for construction, fill material and/or additional fill material will come from the borrow area. The borrow area will also be used as a disposal site for material deemed unsuitable from excavation at the pump station site.

Figure 6 Borrow area (32.46176/-90.89743) and access road right-of ways.

Reforestation

The nonstructural feature of reforestation of agricultural lands primarily below 87.0 feet, NGVD, will provide significant long-term benefits to water quality and improve the functional capacity of the reforested wetlands. Additionally, the reforestation of agricultural lands below 87.0 feet, NGVD, will provide additional flood reduction benefits to the Proposed Plan, which will be in addition to those provided by the operation of the pump station. Flood reduction benefits will be gained by removing these lands from future economic damages resulting from flooding. The reforestation and conservation features will be monitored by the MVK. After planting, tree survival will be visually monitored to ensure success. Conservation structures will also be visually monitored to ensure proper installation at the designated location. Monitoring will continue after successful establishment of the trees and structures through remote-sensing techniques with occasional visual onsite inspection.

NOTE: Blocking out. The reforestation/conservation features easement acquisition limits were established based upon flood frequency state elevations. However, based upon sound real estate practices and guidance as found in the USACE real estate regulations, blocking out will be utilized to address such items as access, the extent of severance damages, and avoidance of an uneconomic remainder. The blocking out will result in the acquisition of some lands outside a given flood event or elevation. The MVK Real Estate Division has vast experience in the acquisition of lands based upon elevation and typically uses a blocking factor of 30 percent. This figure was utilized for calculating the acreages to be acquired for the reforestation/conservation features easement for both the recommended plan from the 2007 Main Report and the Proposed Plan.

Mitigation

Thirty-four supplemental low flow groundwater wells, associated features, and access roads will be installed as a mitigation feature of the project to help alleviate the negative environmental impacts resulting during minimum flow conditions within the Big Sunflower and Steele Bayou watersheds of the Yazoo Basin. The supplemental low flow groundwater wells will offset any unavoidable losses to aquatic resources. The supplemental low flow groundwater wells will be located north of the Yazoo Study Area in Washington, Bolivar, and Coahoma counties,

Mississippi within the project drainage area and will be installed adjacent to the Mississippi River levee, upstream of the backwater area, in areas primarily utilized for agricultural production, and adjacent to headwater streams. Figure 7 shows the locations of the 34 supplemental low flow groundwater wells in relation to the Yazoo Study Area. The right-of-ways for the 34 supplemental low flow groundwater wells, which includes associated features, and access roads will be approximately 30.9 acres and 12.19 acres respectively.

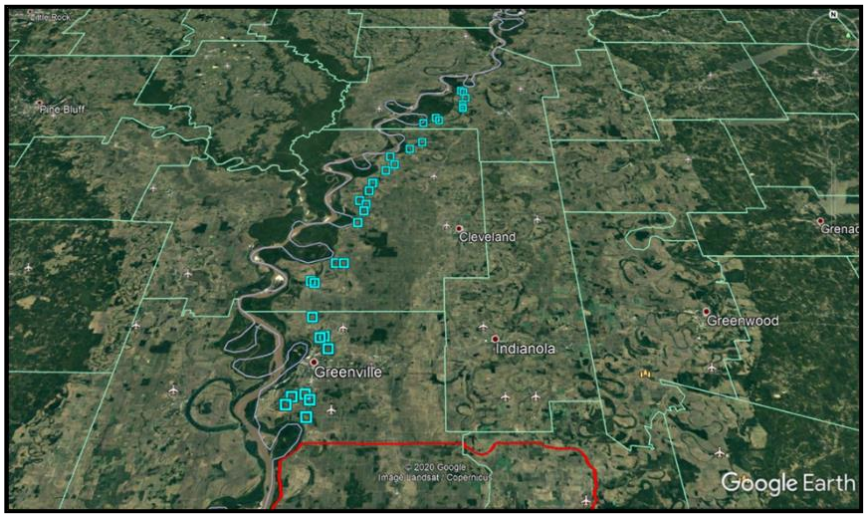

Figure 7 Supplemental low flow groundwater well locations.

Discharge pumps will be electrically driven, and the discharge pipe will be installed from each supplemental low flow groundwater well to the bank of the receiving stream and stabilized with riprap. All disturbed area will be stabilized with riprap to prevent erosion. The supplemental low flow groundwater wells would supply up to 5 cfs per well during traditionally low flow periods. It is anticipated that approximately 100-150 cfs would be delivered cumulatively for all 34 wells. The supplemental low flow groundwater wells would only be operated during periods of low flow (generally during the fall), and would not contribute to water levels during backwater flood events. The supplement low flow groundwater wells are designed to restore stream flow to historic conditions (Figure 8). Water levels in the Yazoo Study Area would be maintained between 68.5 and 70.0 feet, NGVD, during low flow periods by the Steele Bayou water control structure. This addition of water will increase the velocities and water expansion/ wetted surface in the stream channels of the headwaters of the Yazoo Study Area, therefore improving aquatic habitat for fish, benthic macroinvertebrates, and mussels and ultimately benefitting up to 650 miles of stream within the Sunflower Basin.

Engineering studies will evaluate the geologic and hydrogeologic conditions at potential supplement low flow groundwater well sites. Installation of the supplemental low flow groundwater wells will disturb a minimal amount of land at each site and impacts to these disturbed areas shall be minimized with best management practices.

Acquisition of 2,405 acres of frequently flooded agricultural lands in fee title and subsequent reforestation of these lands will be pursued to offset any unavoidable losses to wetlands, aquatic, terrestrial, and waterfowl resources. The location of these lands are unknown at this time but

prior to completion of the supplemental environmental impact statement document, a mitigation plan for these lands will be developed. Compensatory mitigation for unavoidable impacts due to the construction of a project is determined after avoidance and minimization of impacts are considered. The primary method to achieve mitigation is the reforestation of agricultural lands. Loss of bottomland hardwoods wetlands is a major regional concern. Reforestation of the 1- and 2-year floodplain addresses this concern. Therefore, the MVK will focus mitigation on reforestation of bottomland hardwood on agricultural lands, which provides benefits to terrestrial, aquatic, wetlands, and waterfowl.

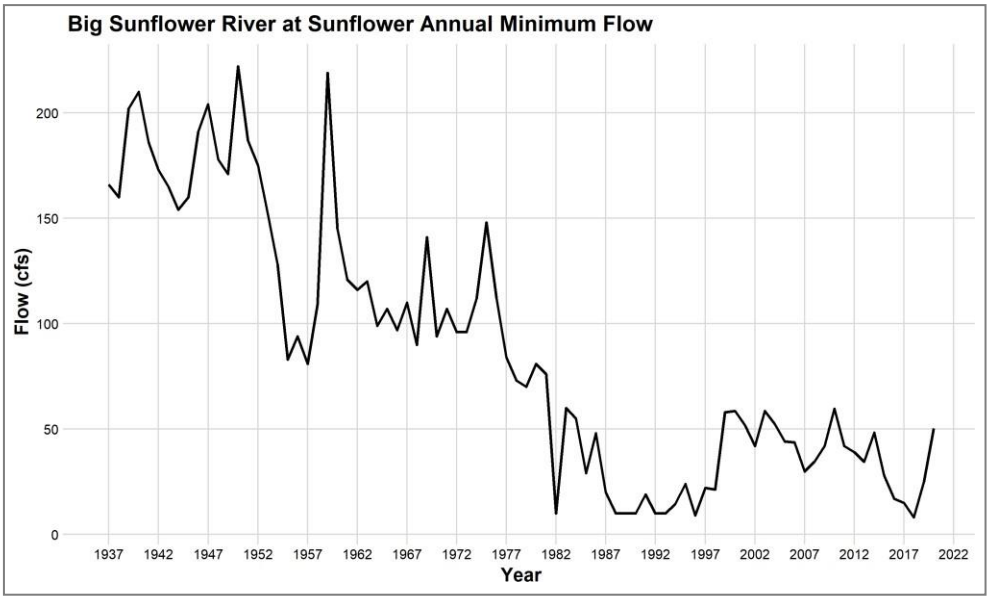

Figure 8. Annual minimum flow at the Big Sunflower River at Sunflower from 1937 through 2019.

Occurrence of Protected, Threatened and Endangered Species
(See attached Yazoo Backwater Project Threatened and Endangered Species Appendix for additional information)

Species	Status	Occurrence
Pondberry (*Lindera melissifolia*)	Endangered	Known
Wood Stork (*Mycteria americana)*	Threatened	Potentially
Northern Long-eared Bat (*Myotis septentrionalis)*	Threatened	Likely in low numbers
Eastern Black Rail (*Laterallus jamaicensis)*	Proposed Threatened	Unlikely
Piping Plover (*Charadrius melodus)*	Threatened	Likely (transient)
Red Knot (*Calidris canutus)*	Threatened	Likely (transient)
Least Tern (*Sternula antillarum athalassos)*	Endangered	Likely
Pallid Sturgeon (*Scaphirhynchus albus)*	Endangered	Potentially
Fat Pocketbook (*Potamilus capax)*	Endangered	Potentially
Rabbitsfoot Mussel (*Theliderma cylindrical)*	Threatened	Potentially
Sheepnose Mussel (*Plethobasus cyphyus)*	Endangered	Potentially

Conclusion and Determination (see attachment for further detail)

Based on historic data and recent surveys, there is low probability of any of the above listed species to occur in the Yazoo Study Area. Therefore, USACE has made the determination that any impacts that might occur would be insignificant and the Proposed Plan may affect but would not likely adversely affect any of the listed species discussed above (with the exception of the pondberry). Please review the above and attached information and inform MVK as to whether or not you agree with our determinations. If you have any questions about the project or need additional information contact Ms. Sara Thames, Biologist/Environmental Manager at (601) 631-5894.

YAZOO BACKWATER PROJECT THREATENED AND ENDANGERED SPECIES

1.0 INTRODUCTION

This appendix evaluates the potential effects of the Proposed Plan on ten federally-listed species (threatened and endangered species, TES) protected under the Endangered Species Act (ESA) of 1973. Consequently, federal agencies are required to determine whether their actions may affect listed or proposed species and designated and proposed critical habitat. This appendix documents the U.S. Army Corps of Engineers (USACE) rationalization supportive of the effects of the Proposed Plan on protected resources. The pondberry will be coordinated separately as there is currently not enough data to make an effects determination.

Biological and ecological data for these listed species, such as life history and critical habitat, is based on both published and unpublished literature, findings of historic and contemporary USACE investigations (e.g., terrestrial field studies and aquatic sampling events), and communications with experts including consultation with the U.S. Fish and Wildlife Service (USFWS).

This appendix segregates the information on TES based on likelihood of occurrence as (a) those likely to be present in the Yazoo Study Area and are therefore the most likely to be potentially impacted by the Proposed Plan, and (b) those listed species that might be present in small numbers, but for which implementation of the Proposed Plan is unlikely to have any discernable impacts. Also addressed are those federally listed species expected to only be present in a transient manner.

2.0 THREATENED OR ENDANGERED SPECIES

This section presents information on federally listed species in the project footprint as listed on the USFWS Information Planning and Consultation (IPaC) website (https://ecos.fws.gov/ipac/). The listed species include: **Wood Stork**, **Northern Long-eared Bat**, **Eastern Black Rail**, **Piping Plover**, **Red Knot**, **Least Tern, Pallid Sturgeon**, **Fat Pocketbook**, **Rabbitsfoot**, and **Sheepnose**. Information on federally endangered **Pondberry** (*Lindera melissifolia*) will be described separately as part of Section 7 consultation with the USFWS. This report also provides an evaluation of the various alternatives for avoiding, minimizing, and compensating unavoidable adverse impacts to TES during the construction and operation of the pump station in the Yazoo Study Area.

2.1 Species/Critical Habitat Descriptions

2.1.1 Wood Stork

Description

The USFWS listed the Wood Stork (*Mycteria americana*) as federally endangered in February 1984 (Federal Register 49:7335). The recovery plan was for the breeding population within the U.S. and was approved 09 September 1986. The Wood Stork is a large, long-legged waterbird, averaging 89 to 102 centimeters (35 to 40.2 inches) in height, with a wing-span of 152 to 165 centimeters (59.8 to 65 inches) (Coulter et al. 2020). The plumage is white, except for black primaries and secondaries and a short black tail. The head and neck are largely unfeathered and gray in color. The bill is large, and thick at the base, and slightly decurved. Juveniles are light gray with a yellowish bill (Coulter et al. 2020).

Taxonomic Status

The Wood Stork is one of 17 true storks (Family Ciconiidae) worldwide, and is the only stork regularly occurring in the U.S. The Wood Stork is also known regionally or locally as the wood ibis, ironhead, flinthead and gannet.

Range and Population Level

The Wood Stork may have formerly bred in all the coastal southeastern U.S. from Texas to South Carolina. Currently, U.S. breeding is restricted primarily to Florida. The current population is difficult to assess, since not all birds nest each year. Presently, the Wood Stork breeding population in the U.S. is thought to number about 11,000 birds. While a prior record of six Wood Storks engaged in breeding activity near Vicksburg, Mississippi, was documented in the late 1990's (Mueller and McCabe 1997), the breeding attempts were not successful. Another distinct, non-endangered population breeds from Mexico to south northern Argentina. A post-breeding dispersal brings birds (Mexican population) north up to the Mississippi Alluvial Valley (MAV). Mexican Wood Storks in the MAV number approximately 1,000 to 5,000 birds, depending on the year (Coulter et al. 2020).

Habitat Requirements

The U.S. breeding population of the Wood Stork occurs primarily in southeastern swamps and wetlands, usually nesting in cypress or mangrove swamps and feeding in freshwater or brackish wetlands. This bird is highly gregarious in both its feeding and nesting behavior. Attractive feeding areas include shallow depressions (approximately 15 to 50 centimeters [7 to 9 inches] deep) in marshes or swamps that concentrate the fish during low water periods. Borrow areas where fish become concentrated during periods of low water are particularly important as foraging sites for this species. The Wood Stork uses a highly adaptive tactolocation technique, called grope foraging (Coulter et al. 2020). This foraging technique seems adapted for feeding on schools of small fish in shallow water.

Effects Analysis

The generally accepted explanation for the decline of the Wood Stork in the U.S. has been the reduction in the food base necessary to support breeding colonies. This reduction has been attributed to the direct loss of wetland habitat as well as changes in hydrology that render coastal wetlands and swamps unsuitable for foraging. The loss of breeding habitat also may have impacted Wood Stork populations. Other less significant factors include prolonged drought and flooding, raccoon (*Procyon lotor*) predation on nests, and human disturbances to nesting colonies. Changes to hydrology within the Yazoo Study Area from the Proposed Plan will

reduce flooding in areas above 87 feet NGVD, consequently decreasing foraging and any potential breeding habitat (Mueller and McCabe 1997). However, given the extreme rarity of occurrences of birds from the Florida breeding population in the Yazoo Study Area, the only actual potential impacts are to birds from the non-listed Mexican population seeking foraging habitat.

Conclusions and Determination of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Wood Stork. The avoid, minimize, and mitigate environmental measures included in the Proposed Plan would assist in reducing the possibility of loss of suitable habitat for the Wood Stork. The measures include avoiding, to the maximum extent possible, environmental damage to riverside woodlands and forested wetlands by siting direct impacts of pump station construction within agricultural lands to the extent practicable. While the Proposed Plan will significantly reduce flooding above 87 feet NGVD, there should be sufficient remaining wetland foraging habitat for non-breeding Mexican Wood Storks. Overall, the Proposed Plan should not adversely impact the Wood Stork, directly, indirectly, or cumulatively.

2.1.2 Northern Long-Eared Bat

Description

The Northern Long-eared Bat (*Myotis septentrionalis*) is a medium sized bat that weights 5 to 10 grams and has a total length of 78 to 96 millimeters (Trani et al., 2007). When laid flat against the head, the ears extend past the nose. Other identifying characteristics include a long pointed tragus and keeled calcar.

Taxonomic Status

The Northern Long-eared Bat is a monotypic species (Trani et al., 2007). It was once believed to be a subspecies of the Keen's Myotis (*Myotis keenii*) but was later recognized as a unique species based on morphology and geographic separation (van Zyll de Jong, 1979).

Range and Population Level

The Northern Long-eared Bat is a widely distributed species with the northern edge of its range extending from Newfoundland, Canada to Manitoba and the southern edge of its range extending from Florida to Wyoming (Trani et al., 2007). Populations are also known to occur in northern Louisiana and western Mississippi (USFWS, 2020a). Historically, Northern Long-eared Bats were more abundant in the northeastern U.S. and southern Canada (Thompson III, 2006). In fact, the species was not observed in Louisiana until 2000 (Crnkovic, 2003).

Habitat Requirements

During the day, Northern Long-eared Bats typically roost under the exfoliated tree bark or tree hollows (Trani et al., 2007), though they will occasionally roost in buildings. Roost trees used by Northern Long-eared Bats vary greatly in species and size, and include both live and dead trees. At night, Northern Long-eared Bats will leave the roost tree and commute for foraging habitat, typically in mature closed-canopy forest (Patriquin and Barclay, 2003), but they will also use clearings, ponds, and road corridors (Trani et al., 2007). In the winter, Northern Long-eared

Bats migrate to caves where they hibernate. In the northern part of its range, bats begin hibernating in August and do not emerge fully until March. Less is known about the timing of hibernation in the southern part of its range.

Effects Analysis

The abundance of Northern Long-eared Bats has declined significantly over the past decade. This is due primarily to the introduction of the fungal disease White-nose Syndrome (WNS). WNS was first detected in 2006 at a cave in New York. It has since spread to bats in 35 states and 7 Canadian provinces including Mississippi where it was first detected in 2015 (USFWS, 2020b). In hibernacula where WNS is present, the disease has caused Northern Long-eared Bat populations to decline by approximately 98% (Reeder and Moore, 2013). Because a cure for WNS has not been found to date, conservation efforts have focused on maintaining suitable habitat. The Proposed Plan may remove potential roosting and foraging habitat through the clearing of land for pump station construction.

Conclusions and Determination of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Northern Long-eared Bat and any incidental take is not prohibited by the final 4(d) rule (see attached Northern Long-eared Bat Streamlined Consultation Form). Although the Proposed Plan may alter hydrology over large portions of the Yazoo Study Area, these alterations will not cause loss of forest habitat. In fact, installation of the pump station may improve habitat quality by restoring a more natural hydrologic regime that will improve forest health. The clearing of land for pump station construction will also have minimal impact on bats. The total area of the pump station and borrow area footprint is 292.6 acres which is less than 0.03% of the 926,000 acre Yazoo Study Area. Furthermore, only a portion of the pump station footprint is currently forested, much of which is mid-successional forest with a dense understory that is avoided by Northern Long-eared Bats. Because the project will have little impact on Northern Long-eared Bat habitat, the Proposed Plan will not significantly harm this species.

2.1.3 Eastern Black Rail

Description

The Black Rail (*Laterallus jamaicensis*) is the smallest rail species in North America. Body length ranges between 10 to 15 centimeters (3.9 to 5.9 inches) and wing span between 22 to 28 centimeters (8.7 to 11 inches) (Eddleman et al. 2020). The adult is generally black with gray head and breast and a black crown, while the upper back is black with white speckling. This rail has distinctive red eyes, and the back of the neck possesses a distinctive brown to chestnut colored patch (Eddleman et al. 1994). Immatures have less white speckling, and reddish or hazel eyes that will turn red at about 3 months of age (Eddleman et al. 1994). Black Rails are very secretive, and rarely seen. This bird possess a large vocal repertoire and is generally detectable while vocalizing during the breeding season, and often only through use of playback recordings.

Taxonomic Status

There are two Black Rail subspecies in the conterminous U.S. A western population (*L. j. coturniculus*) in California, Arizona, and Baja California, is largely resident in the region. The eastern population (*L. j. jamaicensis*) is partly migratory, wintering in the southeastern U.S., Caribbean, and Central America. There is a small isolated population of the Eastern Black Rail in Central North America in Colorado and Oklahoma, with isolated, but confirmed breeding in Minnesota and Michigan; breeding records are rare in these states and sites have not been occupied consistently during the past 50 years (Eddleman et al. 2020). The Eastern Black rail is the subspecies with any chance of presence within the Yazoo Study Area.

Range and Population Level

Little is known about the secretive Black Rail. There are two primary populations in western and eastern U.S. (see above). Most populations have experienced significant population declines, especially on the east coast, where some coastal populations have declined by 80% or more (Watts 2016, Smith et al. 2018, USFWS 2018), and some interior population are no longer present (Watts 2016, Smith et al. 2018). Some local populations may have stabilized to some degree due to wetland restoration efforts during the past 25 years (Eddleman et al. 2020), however, this has been insufficient to overcome declines, and the eastern subspecies was proposed for federal listing in 2010 (USFWS 2018). In September 2013, a 12-month review by the USFWS recommended that the subspecies be federally listed as threatened. Currently, the listing process has stalled, and the Eastern Black Rail is still proposed for listing as threatened. The Eastern Black Rail also is designated as state endangered or threatened in seven states within the subspecies' range, including Delaware, Illinois, Indiana, Maryland, New Jersey, New York, and Virginia. The state of Mississippi designates the Black Rail as S2N, meaning it is imperiled (non-breeding only) because of rarity.

Habitat Requirements

Black Rails can be found in tidally or non-tidally influenced brackish salt water or freshwater meadows and marshes (Smith et al. 2018, Eddleman et al. 2020). These habitats are usually densely vegetated, however, this species may occasionally occupy upland transition portions of these habitats. Coastal populations are losing habitat due to sea level rise and inundation of nesting sites; while in North Carolina, interior populations have declined to the point where they are no longer detected (Watts 2016, Smith et al. 2018). In additional, Black Rails may occupy impounded and non-impounded wetlands. Little is known about the Black Rail during migration, however, some evidence suggest that it may utilize wet prairies, meadows and hayfields (Eddleman et al. 2020).

Effects Analysis

The primary cause for population declines of the Eastern Black Rail is habitat loss through wetland drainage and conversion to agriculture, or urban and suburban expansion (Watts 2016, Smith et al. 2018, Eddleman et al. 2020). Sea level rise and inundation of nests and nesting habitat is also a large contributor to coastal populations (Smith et al. 2018). Expansion of non-native marsh species such as the common reed (*Phragmites* ssp.) contribute to habitat degradation and are detrimental to this species (Eddleman et al. 2020). This species also is susceptible to harsh winters, and is a common prey item for foxes, raccoons, and domestic cats. Rails may be more susceptible to predation during high tides.

Conclusions and Determination of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Eastern Black Rail. There is very little marsh habitat suitable for Eastern Black Rails in the Yazoo Study Area. Construction and operation of the Proposed Plan will have minimal impacts because of the lack of existing marsh habitats; therefore, impacts on the Eastern Black Rail are considered to be negligible.

2.1.4 Piping Plover

Description

The Piping Plover (*Charadrius melodus*) is a small white to sandy, sparrow-sized shorebird with a black chest band and black eye-to-eye strip over the forehead. The males have a thicker chest band than females. Both sexes have orange/yellow to red legs and an orangish beak tipped with black. This bird blends in with open sand and gravel beaches and flats and is often difficult to spot. A short plaintive whistle-like call is often the first clue that the species is nearby.

Taxonomic Status

There are two subspecies in the conterminous U.S. The eastern population (*C. m. melodus*) that breeds along the Atlantic Coast, and a central Midwest populations that breed around the Great Lakes and within river systems in the Great Plains (*C. m. cicumcinctus*) (Elliott-Smith and Haig 2020). While the subspecies designation is still debated, mitochondrial DNA analyses suggest that these birds are reproductively isolated, with breeding populations around the Great Lakes more closely related to the Great Plains populations than populations along the Atlantic Coast.

Range and Population Level

The three distinct populations total approximately 7,000 birds, with slightly more than half along the Eastern Coast of the U.S. and Canada. On the breeding grounds, the eastern population is listed as threatened under ESA, while the Great Lakes/Great Plains populations are listed as endangered. Since 1999, some populations of this species have shown increases, largely due to increased surveys and monitoring efforts, plus increased protection and management, including predator control during the breeding season. Nevertheless, this species remains well under population levels required to remove from ESA protection, and populations likely will continue to require careful management to fully achieve recovery (Elliott-Smith and Haig 2020).

Birds from all populations migrate, and most winter along the Atlantic and Gulf Coasts of the southeastern U.S. south to Mexico and Central America. Some populations winter in the Bahamas (Elliott-Smith and Haig 2020). The Atlantic Coast population largely winters along the coasts of the southeastern U.S., while Great Lakes/Great Plains birds winter along both the Gulf and Atlantic Coasts of Florida; birds along the Gulf Coast have highest abundance along the coast of Texas (Elliott-Smith and Haig 2020). On occasion, birds from the Atlantic Coast and the Great Lakes/Great Plains populations may overwinter together along the Gulf Coast; birds from the Great Lakes/Great Plains may move from wintering sites along the Florida Atlantic Coast to sites along the Gulf Coast in a single winter season (Elliott-Smith and Haig 2020). It is the Great Plains population that has the highest likelihood of migrating through the Yazoo Study Area during the fall and spring.

Habitat Requirements
Piping plovers can be found on expansive coastal or riverine sandy beaches and gravel flats. For the Atlantic Coast population, access to bayside or inlet foraging sites is important, especially for recently hatched young.

Effects Analysis
Loss and degradation of breeding habitat and increases in predation are the primary factors attributed to the decline of this species. Disturbance and habitat modifications on wintering and migratory habitat also are negatively impacting nonbreeding populations (Gibson et al. 2018). Midwestern populations are susceptible to habitat loss through dredging on inland rivers (Hunt et al. 2018), which reduces formation of natural sandy spits and beaches. Both eastern and Great Lakes/Great Plains breeding populations are susceptible to disturbance from human activities, and predation from domestic animals. Other native avian and mammalian predators associated with increased populations due to human development are also impacting reproductive success (Elliott-Smith and Haig 2020).

Conclusions and Determination of Effects
The Proposed Plan may affect, but is not likely to adversely affect the Piping Plover. Most detections of Piping Plover in western Mississippi have been immediately along Mississippi River sandbars. Our analysis of eBird data shows no detections within or near the Yazoo Study Area, including the Yazoo River, with only a few detections near the Mississippi River. Generally, the Yazoo Study Area is too far south to serve as breeding habitat and too far north from the Gulf Coast to be used regularly as wintering habitat. Therefore, this species is a very rare visitor during the spring and fall migration seasons. Construction and operation of the Proposed Plan will have minimal adverse impacts on open mudflats and sandy habitats which this species might use during migration; therefore, impacts on this species will be very low.

2.1.5 Red Knot

Description
The Red Knot (*Calidris canutus*) is a stocky, medium-sized sandpiper with a characteristic red to salmon breast and a pale white belly behind the legs (Baker et al. 2020). These birds have a visibly small head, with a beak slightly longer than the head that tapers from a thin tip to a relatively thick base. Bills and legs are black and individuals usually are observed in a hunched position while foraging. Back feathers, axillaries, and tertials usually have dark brown to black centers that are tinged with reddish, greyish to whitish edges, and the tail feathers are grey. Primaries are dark brown to blackish, and secondaries are grey and there is a thin pale white wingbar. Males are usually brighter in coloration than females, and females usually have a less visible eye-line. Females may also have lighter rufous underparts with darker subterminal markings. Non-breeding plumage is nearly identical among the sexes; usually plain gray above with white fringes on the upper feathers. Underparts are streaked on upper breast to the flanks (Baker et al. 2020).

Taxonomic Status

There are two Red Knot subspecies in the conterminous U.S. The eastern population (*C. c. rufa*) and the western population (*C. c. roselaari*).

Range and Population Level

C. c. rufa breeds in the artic and migrates along the Atlantic Coast. This subspecies may winter along the Gulf of Mexico, while other portions of the population will winter as far south as the southern tip of South America. A western population that breeds in Alaska (*C. c. roselaari*) and Russia winters along the Pacific Coast and into Central and South America (Baker et al. 2020). This subspecies may also spend portions of the migratory and wintering periods along the Gulf of Mexico. The *C. c. roselaari* population was estimated at approximately 17,500 birds in 2012, while the *C. c. rufa* population was estimated at 26,000 during migration in the Delaware Bay, New Jersey, in 2012 (Baker et al. 2020).

Habitat Requirements

During the breeding season, Red Knots usually nest in tundra and glacial sand and gravel habitats. They may also utilize marsh habitats on foothill slopes near riparian ponds and streams (Baker et al. 2020). During the non-breeding seasons, these birds use coastal habitats in tidal inlets of bays and estuaries, and are rarely found inland. Such habitats include tidal mud and sand flats, where they are dependent upon an abundant and diverse benthic community as a food source. This food source is critical in providing the essential nutrients required to survive the migratory journey, overwintering survival, and for breeding and reproduction. In coastal habitats, they may utilize peat banks, salt marshes, lagoons, and mangrove habitats, while roosting along sandy beaches and dunes (Baker et al. 2020). Along the Atlantic Coast, *rufa* Red Knots are known to focus on specific migratory hotspots, including Delaware Bay, where they are dependent upon the eggs of the horseshoe crab (*Limulus polyphemus*) during spring migration (Niles et al. 2008, 2009, Baker et al. 2020).

Effects Analysis

In 2014, the *rufa* Red Knot was listed under ESA as threatened. Migratory populations along the Atlantic Coast have experienced significant declines approaching 80% in some localities, especially in Delaware Bay (Niles et al. 2008) and wintering areas in South America (Andres et al. 2012). The blood of horseshoe crabs contains amebocytes which are used for bacterial endotoxins in medical applications. Harvesting of female horseshoe crabs for their blood has contributed to sharp declines of these animals in the Delaware Bay and elsewhere, and has caused a corresponding decline of *rufa* Red Knots (Niles et al. 2009). Significant restrictions on the horseshoe crab harvest, plus additional efforts to protect important migratory staging areas and wintering areas may be achieving some success in restoring populations of Red Knots and other shorebirds (Andres et al. 2012, Baker et al. 2020), however, far more time and effort will be needed to restore these populations.

Conclusions and Determination of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Red Knot. The Yazoo Study Area is far outside breeding and wintering areas for the Red Knot. Our assessment of eBird data shows only three historical detections near the Mississippi River in western Mississippi, and all were north of Greenville on the Arkansas side of the river. Therefore, any potential impacts of the Proposed Plan will occur during migratory stopover. There is the

possibility that mud and sand flats in the Yazoo Study Area could be used by *C. c. roselaari* or *C. c. rufa* during migration, but as designed the Proposed Plan is unlikely to have significant impacts on such habitats and is unlikely to adversely affect populations of the Red Knot.

2.1.6 Least Tern

Description
The Least Tern (*Sternula antillarum*) is a small white and black tern with a wing-span of 50 centimeters (20 inches), a body approximately 22 to 24 centimeters (8.7 to 9.4 inches) long, and weighing about 39 to 52 grams (1.4 to 1.8 ounces) (Thompson et al. 2020). Least Terns have a small black cap on the head, and a black strip through its eyes, and have a long yellow bill with a black tip. There is a small patch of white just over its bill. The legs are yellow, and the wings are gray with black primaries (Thompson et al. 2020).

Taxonomic Status
There are three distinct subspecies of Least Tern in the conterminous U.S. *S. a. antillarum* breeds along the Atlantic and Gulf Coasts, *S. a. browni* breeds along the Pacific Coast and Baja Mexico, and *S. a. athalassos* breeds along interior rivers within the conterminous U.S. (Thompson et al. 2020).

Range and Population Level
The breeding interior subspecies, *S. a. athalassos*, currently is federally protected under ESA and is the subspecies most likely to be encountered within the Yazoo Study Area. The breeding range includes most major river systems in the central U.S., with largest populations along the Missouri, Arkansas, Red, and Lower Mississippi Rivers. Least Terns regularly winter along the Pacific Coast of southern Mexico, and along the eastern coasts of Mexico, Central and South America, and south to Argentina and Brazil (Thompson et al. 2020). In total, the three populations are estimated at approximately 43,000 pairs. Most of these birds (21,500 pairs) nest along the Atlantic and Gulf Coasts. While the Atlantic and Gulf Coast populations are not federally listed under ESA, they are listed within individual states and are considered vulnerable throughout their range (Thompson et al. 2020). The California Least Tern (*S. a. browni*) was listed as endangered in 1972 and has made significant recovery progress with pairs increasing from an initial estimated 600 pairs at time of listing to a current estimate of 4,500 pairs, but threats and stressors to the population warrant continued ESA protection (Thompson et al. 2020). The Interior population of Least Tern was listed in 1985 with under 10,000 breeding pairs, but has met recovery goals with an estimated 17,500 nesting pairs (Lott 2006, USFWS 2013, Hartfield 2017), and was proposed for removal from the Federal List of Endangered and Threatened Wildlife in 2019 (84 FR 56977).

Habitat Requirements
Least terns nest on riverine (shorelines and sandbars), marine or estuarine shores, and typically on sparsely vegetated to barren areas with gravel or sandy substrates. Bare, open sand islands in riverine or coastal settings, separated sufficient distance from shoreline, that limit access by mammalian predators, usually provide the best nesting habitat for this species (Thompson et al. 2020). Naturally formed islands may provide the best nesting opportunities (Hunt et al. 2018), but along the Atlantic Coast, islands formed by deposition of dredged material are of increasing

importance to this species. In areas with limited nesting habitat, or in years when interior rivers are flooded, this species is known to nest on gravel roof tops (Thompson et al. 2020).

Effects Analysis

Maintenance dredging in riverine and coastal habitats can alter natural sedimentation processes leading to reduced formation of natural islands, sand spits, beaches, intertidal zones, and estuarine marshes that may reduce important nesting, roosting and foraging areas for this species. The Yazoo Basin, which is adjacent to the Mississippi River, may contain marginally important nesting and foraging habitat for this species that could be negatively impacted by the Proposed Plan. The interior subspecies is known to nest and forage extensively along the Mississippi River in western Mississippi. However, an analysis of eBird data only revealed six detections within the Yazoo Study Area over the past 25 years.

Conclusions and Determination of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Least Tern. Generally, the Yazoo Study Area is too far north to serve as breeding habitat for coastal *S. a. antillarum*. The Lower Mississippi River (LMR) supports the largest breeding populations of *S. a. athalassos* (Lott 2006); however, the Yazoo Study Area is within an upstream tributary outside of the LMR area where the bulk of the population breeds. In addition, the Proposed Plan will have no direct impact on nesting habitat along the Mississippi or Yazoo Rivers. However, by altering hydrology, the Proposed Plan may have minimum adverse impacts on potential foraging habitat in the Yazoo Study Area for *S. a. athalassos*. This subspecies could be found attempting nesting in years when the Mississippi River is above flood stage. While the potential for impacts is extremely low for this species, verification of the absence of Least Terns would ensure no indirect and cumulative impacts to the species.

2.1.7 Pallid Sturgeon

Description

The Pallid Sturgeon (*Scaphirhynchus albus*) is large elongate fish with a flattened, shovel-shaped snout (rostrum). The eyes are small, the spiracle is absent, and belly squamation is generally lacking. Individuals possess five longitudinal rows of sharply keeled bony plates (scutes) extending along the dorsal midline, lateral midline, and ventral edge of lateral body surface. The elongate body tapers posteriorly into a long, slender, and completely armored caudal peduncle. A long caudal filament often extends from the upper lobe of the caudal fin; a feature more prevalent in younger individuals. There are two sets of fringed barbels placed along ventral surface of the rostrum with the outer pair positioned more anteriorly and decidedly longer than the inner pair. Body coloration is uniformly, grayish-white to light tan, and is generally lighter in color than the Shovelnose Sturgeon (*Scaphirhynchus platorynchus*) (Ross 2001, Robison and Buchanan 2020).

Taxonomic status

Pallid Sturgeon belong to the family Acipenseridae (Actinopterygii: Acipenseriformes) and members of this order are often referred to as “living fossils” because of their prehistoric appearance and representation in the fossil record from the Cretaceous period of geological history (Hilton and Grande 2006). The species is a benthic, riverine fish that occurs in the

Mississippi River Basin, including the Mississippi and Missouri rivers, and their major tributaries (i.e., Platte and Yellowstone rivers), and the Mississippi's major distributary, the Atchafalaya River (USFWS 1990). The Pallid sturgeon was listed as endangered by the USFWS in 1990 (USFWS 1990). A recovery plan was released in 1993 with the most current revision approved in 2014 (USFWS 1993, 2014). Further protection was provided with the listing of the Shovelnose Sturgeon as threatened under the Similarity-of-Appearance Provisions of the ESA in 2010 (USFWS 2010). This provision only provides a protective status in river systems where both species co-occur.

Morphological and genetic variation exists across the species range with Pallid Sturgeon from the upper Missouri River having lower levels of mitochondrial DNA and microsatellite variation. Genetic variation increases in the southern portion of the range, and Pallid Sturgeon become more genetically similar to the more variable Shovelnose Sturgeon (Campton et al. 2000, Schrey and Heist 2011). Murphy et al. (2007) observed morphological variation across the range of both Pallid and Shovelnose Sturgeon noting distinct differences in morphology were more prevalent in the upper Missouri River. Morphological features varied more in the lower Missouri and Mississippi rivers with individuals spanning a continuum of morphotypes raising concerns on field identification methodologies (Wills et al. 2002, Jordan et al. 2019). In addition, northern populations of Pallid Sturgeon attain a larger size, mature at a later age, and exhibit greater longevity (Keenlyne and Jenkins 1993, Killgore et al. 2007b). Estimated age of first spawning may be similar between the populations although at a smaller size for southern populations; however, these populations possess greater gondal mass equating to higher fecundity per unit of body weight (George et al. 2012).

Range and population level

Within Mississippi, Pallid Sturgeon occur within the mainstem of the Mississippi River (Killgore et al. 2007). There is a single historic record (1987) from the Big Sunflower River in Sharkey County, 12 miles northwest of Sataria (Ross 2001). Cook (1959) noted the occurrence of the Pallid Sturgeon in the Yazoo River was possible since Shovelnose Sturgeon were routinely caught in this river by commercial fishermen during the early 1900's. In addition, there are several museum records for Shovelnose Sturgeon in the Yazoo drainage (Mississippi Museum of Natural Science (MMNS) 2434, 51673 and 55110) dating 1937, 2007 and 2009 (MMNS 2020). A recent capture (23 May 2020) by a fisherman was noted in the tailwaters of Sardis Reservoir, a flood control reservoir on the Little Tallahatchie River (Yazoo drainage) in Panola County (Figure 1) (M. Wagner, Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) personal communication). No recent specimens of Pallid Sturgeon have been reported from the Yazoo Study Area. A more detailed account for the species including the LMR population is included in Killgore et al. (2014).

To promote directed recovery efforts, Pallid Sturgeon populations were assigned to four management units (USFWS 2014). These areas were selected as areas of high importance for recovery task implementation based on population variation (i.e., morphological, genetic) and habitat differences (i.e., physiographic regions, impounded, unimpounded reaches) throughout the extensive range of the sturgeon (USFWS 1993). The Great Plains Management Unit (GPMU) extends from Great Falls of the Missouri River, Montana, to Fort Randall Dam, South Dakota, and includes the major tributaries thereof (Yellowstone, Marias, and Milk rivers). The

Central Lowlands Management Unit (CLMU) includes the Missouri River from Fort Randall Dam, South Dakota, to the confluence of the Grand River, Missouri, and includes the major tributaries thereof (lower Platte, lower Kansas Rivers). The Interior Highlands Management Unit (IHMU) includes the Missouri River from the confluence of the Grand River, Missouri, to the confluence of the Mississippi River, Missouri, and the Mississippi River from Keokuk, Iowa, to the confluence of the Ohio River, Illinois. The Coastal Plain Management Unit (CPMU) includes the Mississippi River from the confluence of the Ohio River, Illinois, to the Gulf of Mexico, Louisiana, and includes the Atchafalaya River distributary system, Louisiana.

GPMU: Within the GPMU, the population consists of older adult individuals with no evidence of natural recruitment occurring over the past decades. A stocking plan was initiated in 1997 and continues today. Broodstock are captured from the region with offspring hatchery-reared at Gavins Point National Fish Hatchery until age one before being released. More recently, a fish passage project was developed to increase access to 265 river kilometers of additional river habitat in the Yellowstone River (USFWS 2007, Gerrity et al. 2008, Jordan et al. 2016).

CLMU: There are no naturally occurring wild Pallid Sturgeon remaining in the most upstream portion of the CLMU, including the Missouri River downstream of Fort Randall Dam to Lewis and Clark Lake, the entire population is made up of hatchery-reared fish and translocated wild individuals (USFWS 2007). Stocking in this region began in 1997 and still continues. A recent study conducted in a 50 mile reach of the lower Missouri River downstream from the confluence of the Platte River estimated a population size much higher than those in the GPMU (Steffensen et al. 2012). It is currently unclear whether natural recruitment occurs in this study area (USFWS 2007).

IHMU: It is still unclear the extent of natural recruitment in the lower Missouri River, from Gavins Point Dam to the confluence of the Mississippi River (Steffensen et al. 2010; USFWS 2007). Between 1994 and 2008, nearly 80,000 hatchery-reared Pallid Sturgeon had been released into the lower Missouri River, and as of 2008, only 1% had been recaptured (Steffensen et al. 2010). Wild Pallid Sturgeon are more frequently captured in the MMR, which extends from the confluence of the Missouri River to the confluence of the Ohio River, than in the GPMU and CLMU. In a collaborative sampling effort between 2002 and 2005, researchers from the USACE, Missouri Department of Conservation, and Southern Illinois University, captured 148 Pallid Sturgeon, with only 12 fish of hatchery origin (USFWS 2007). In the MMR, the Pallid to Shovelnose Sturgeon ratio ranges from 1:36 to 1:77 (Killgore et al. 2007a). Age 0 Pallid Sturgeon have been collected in the MMR, although it is unknown where spawning occurs (Hrabik et al. 2007).

CPMU: Pallid Sturgeon have been collected throughout the CPMU represented by multiple age cohorts (Killgore et al., 2007a,b). However, uncertainty exists on the contribution of local spawning and recruitment to populations within the CPMU compared to upstream/tributary spawning followed by downstream migrations of larvae and juveniles (Jordan et al. 2016). Between 1996-2006, 162 Pallid Sturgeon were collected in the LMR, and >500 individuals have been captured to date (Killgore et al. 2007a, USFWS database: http://pallidsturgeon.org/). Pallid:Shovelnose Sturgeon ratios vary between 1:6 to 1:30 (Killgore et al. 2007a). There is a relatively large population (1:6 ratio of Pallid to Shovelnose) of Pallid Sturgeon in the

Atchafalaya River distributary than in other parts of the Pallid Sturgeon range, although it is still unclear whether natural recruitment occurs in this area (Killgore et al. 2007a; USFWS 2007). More than 600 Pallid Sturgeon have been captured and marked in the Atchafalaya to date (USFWS database: http://pallidsturgeon.org/). Age 0 Pallid Sturgeon have been captured in the LMR, although it is unclear exactly where and when spawning occurs (U.S. Army Engineer Research and Development Center (ERDC), unpublished data; Hartfield et al. 2013).

Habitat Requirements

Pallid Sturgeon are typically associated with main channel habitats with relatively deep, flowing water in the Mississippi, Missouri, and Yellowstone rivers. It commonly occurs over sandy substrates but often collected over gravel (USFWS 1993, Bramblett and White 2001, Hurley et al. 2004, Garvey et al. 2009, Koch et al. 2012). Several studies have documented Pallid Sturgeon near islands and dikes, and these habitats likely provide a break in water velocity and an increased area of depositional substrates appropriate for foraging. Increased use of side channel and main channel islands has been noted in spring, and it is hypothesized that these habitats may be used as refugia during periods of increased flow (Garvey et al. 2009, Koch et al. 2012). Telemetry monitoring of Pallid Sturgeon in the LMR indicates use of most channel habitats, including dikes, revetment, islands, secondary channels, etc. (Kroboth et al. 2013). The Pallid Sturgeon occurs within a variety of flow regimes (Garvey et al. 2009). In their upper range, adult Pallid Sturgeon are collected in depths that vary between 2.0 to 48.0 feet, with bottom water velocities ranging 2.0 to 3.0 feet per second (USFWS 1993; Bramblett and White 2001; Gerrity 2005). Pallid Sturgeon in the LMR have been collected at depths greater than 65 feet, with a mean value of 33 feet, and water velocities greater than 6.0 feet per second, with a mean value of 2.0 feet per second (ERDC unpublished data, Kroboth et al. 2013). Turbidity is thought to be an important factor in habitat selection by Pallid Sturgeon, as they have a tendency to occupy more turbid habitats than Shovelnose Sturgeon (Blevins 2011). In the LMR, Pallid Sturgeon have been collected in turbidities of up to 340 Nephelometric Turbidity Units (NTU), with a mean value of 90 NTU (ERDC unpublished data). Critical habitat for the Pallid Sturgeon is currently not designated though a petition is pending (https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=7162).

The Pallid Sturgeon, like other sturgeon species, is a migratory fish species moving upstream annually to spawn (Koch et al. 2012). Movements are generally triggered by increased water temperature and flow in spring months (Garvey et al. 2009, Blevins 2011). Garvey et al. (2009) suggested that Pallid Sturgeon remain sedentary, or remain in one area for much of the year, and then move either upstream or downstream during spring. The Pallid Sturgeon may undertake long-distance, multi-year upstream migrations or movements, based on recaptures of Shovelnose Sturgeon in the Missouri River that were originally tagged in the LMR. Upstream distances approaching 1,245 miles have been recorded (ERDC unpublished data) with similar distances recorded for downstream movements (Kroboth et al. 2013).

Spawning occurs during the spring with a second spawn or an extended spawning period potentially occurring during the fall in southern portions of the range (i.e., Mississippi River) (USFWS 2007). Sexual maturity in female *Scaphirhynchus* spp. does not occur until ages 6 to 17, with spawning taking place every two to three years. Males reach sexual maturity earlier at ages four to nine (Keenlyne and Jenkins 1993, Colombo et al. 2007, Stahl 2008, Divers et al.

2009). The Pallid and Shovelnose Sturgeon at lower latitudes (e.g., LMR) may begin spawning at an earlier age than those in upper portions of the range (e.g., Upper and Middle Mississippi and Missouri Rivers), and as such both species from the LMR are reported to have shorter lifespans and reach smaller sizes (George et al. 2012). Also, LMR Pallid Sturgeon may be more highly fecund than those in northern portions of their range (George et al. 2012). Spawning is associated with coarse substrate (boulder, cobble, gravel) or bedrock, in deeper water, with relatively fast, converging flows, but spawning has never been directly observed in this species (USFWS 1993, DeLonay et al. 2007, DeLonay et al. 2009).

Larval hatchlings are approximately 0.25 inch in total length and predominantly pelagic. They feed on yolk reserves while drifting downstream with the river current for 11 to 17 days, until yolk reserves are depleted (Snyder 2002, Braaten et al. 2008, DeLonay et al. 2009). Drift distance of larval sturgeon is thought to be between 86 to 329 miles (Kynard et al. 2007, Braaten et al. 2008).

Pallid Sturgeon begin exogenous feeding around 11 to 12 days posthatch in upper portions of their range, but exogenous feeding was observed in fish as small as 0.70 inches total length in the LMR (Harrison et al. 2014), which could be as young as six to eight days posthatch (Braaten et al. 2007). The diets of young-of-year and juvenile Pallid Sturgeon and Shovelnose Sturgeon in upper portions of their ranges are primarily composed of aquatic insects and other benthic macroinvertebrates, much like those of adult Shovelnose Sturgeon (Braaten et al. 2007, Wanner et al. 2007, Grohs et al. 2009). In contrast, young-of-year and juvenile Pallid Sturgeon in the LMR feed primarily on Chironomidae over sand in channel habitats (Harrison et al. 2014).

Sturgeon are benthic feeders well-adapted morphologically (ventral positioning of the mouth, laterally compressed body) for the benthic lifestyle (USFWS 1993, Findels 1997). Adult Pallid Sturgeon are primarily piscivorous (but still consume invertebrates), and are thought to switch from feeding primarily on invertebrates to fish at around age five or six (Kallemeyn 1983, Carlson et al. 1985, Hoover et al. 2007, Grohs et al. 2009). In a study of Pallid Sturgeon in the MMR and LMR, fish were a common dietary component primarily represented by Cyprinidae, Sciaenidae, and Clupeidae (Hoover et al. 2007). Other important dietary items for Pallid Sturgeon in the Mississippi River included larval hydropsychid caddisflies, mayflies, and true flies (Hydropsychidae (Insecta: Trichoptera), Ephemeridae (Insecta: Ephemeroptera), and Chironomidae (Insecta: Diptera)) (Hoover et al. 2007). Diet was found to vary depending on season and location which is likely related to prey availability with overall dietary richness found to be greatest in winter months (Hoover et al. 2007); for example, Trichoptera and Ephemeroptera were consumed in greater quantities in winter months in the LMR, while the opposite trend was observed in the MMR (Hoover et al. 2007).

Effects Analysis

Historically, the Pallid Sturgeon occurred over a larger, contiguous riverscape. Today the distribution has been fragmented by large dams and reservoirs with dams on larger tributaries being constructed for power generation, flood control, navigation, and irrigation (Jordan et al. 2016). A decline in numbers has been attributed to several anthropogenic impacts, including habitat modification and commercial harvest of the fish (USFWS 1990). More recent studies

have added water contamination, entrainment, and hybridization to the list of impacts (Divers et al. 2009, USFWS 2009, Blevins 2011, Schrey et al. 2011). Recently, invasive species, particularly Asian Carp, have been added as an emerging concern as they may alter food web dynamics within large river systems (Freedman et al. 2012, Jordan et al. 2016, Kramer et al. 2019). Jordan et al. (2016) notes that approximately 51% of the historical range of the Pallid Sturgeon has been affected to some degree by channelization, 28% has been impounded, and 21% is affected by upstream impoundments that alter flow regimes, depress turbidity and water temperatures, as well as by continuing bank stabilization activities that limit channel meandering (Keenlyne 1983, USFWS 1993, 2007, 2014). While, anthropogenic habitat alterations were the primary factor for listing (USFWS 1990), the extent of these impacts vary by management unit.

The Pallid Sturgeon currently remains endangered. The USFWS (1993) criteria to downlist Pallid Sturgeon from endangered to threatened include a population structure with at least 10% sexually mature females, and sufficient numbers in the wild to maintain population stability. An updated recovery plan was released in 2014 (USFWS 2014) and the criteria for downlisting was expanded:

> A self-sustaining genetically diverse population of 5,000 adult Pallid Sturgeon is realized and maintained within each management unit for two generations (20 to 30 years). In this context, a self-sustaining population is described as a spawning population that results in sufficient recruitment of naturally produced Pallid Sturgeon into the adult population at levels necessary to maintain a genetically diverse wild adult population in the absence of artificial population augmentation. Metrics suggested to define a minimally sufficient population would include incremental relative stock density of stock-to-quality-sized naturally produced fish (Shuman et al. 2006) being 50 to 85 over each 5 year sampling period, catch-per-unit-effort data indicative of a stable or increasing population, and survival rates of naturally produced juvenile Pallid Sturgeon (age 2+) equal to or exceeding those of the adults. Additionally, in this context a genetically diverse population is defined as one in which the effective population size (Ne) is sufficient to maintain adaptive genetic variability into the foreseeable future ($Ne \geq 500$), conserve localized adaptions, and preserve rare alleles.

In addition, the revision (USFWS 2014) noted significant genetic structure throughout the range, redefined management units, and identified the potential of delisting by management area. The primary strategy for recovery of Pallid Sturgeon is to:

> 1) conserve the range of genetic and morphological diversity of the species across its historical range; 2) fully quantify population demographics and status within each management unit; 3) improve population size and viability within each management unit; 4) reduce threats having the greatest impact on the species within each management unit; and, 5) use artificial propagation to prevent local extirpation within management units where recruitment failure is occurring. Pallid sturgeon recovery will require an improved understanding of the status of the species throughout its range; developing information on

life history, ecology, mortality, and habitat requirements; improving our understanding of some poorly understood threat factors potentially impacting the species; and using that information to implement management actions in areas where recovery can be achieved.

Conclusions and Determination of Effects

Based on the effects analysis, the Proposed Plan may affect, but not likely to adversely affect the Pallid Sturgeon. Nearby, LMR populations of Pallid Sturgeon appear to be stable (USFWS 2014, Jordan et al. 2016). This species has been reported to migrate long distances, presumably in association with spawning events. However, little is known about the extent of movement outside of the spawning season. Past occurrences of individuals within the Yazoo drainage are few and likely represent waif occurrences. Currently there are no data to support a routine movement pattern of Pallid Sturgeon from the Mississippi River into the nearby Yazoo drainage.

2.1.8 General Regional Mussel Populations

The freshwater mussel fauna of Mississippi is quite diverse and includes 83 described species (Jones et al. 2019) ranking fifth within the nation in terms of total diversity (Jones et al. 2005). The Yazoo drainage ranks second in the state in terms of richness (n = 44) (Jones et al. 2019) and contains 18 Species of Greatest Conservation Need (MMNS 2015) including three federally listed species (Fat Pocketbook, Rabbitsfoot and Sheepnose).

To provide insight on species distributions and status within the Yazoo Study Area, we compiled multiple data sources to generate a comprehensive database for freshwater mussel inquiries. The initial data source is the extensive database of vouchered museum specimens housed at the MMNS in Jackson, Mississippi (Figure 2), and is composed of over 14,800 records. These data are the basis for Jones et al. (2019) and the material is primarily from Mississippi waterways. Within this collection are the records of Haag and Warren (1998) representing mussel surveys within the Desoto National Forest occurring within the south-central region of the Yazoo Study Area. Additional data sources include recent ERDC-based mussel collections (>2,900 records, Figure 2), archaeological records for the region (Peacock et al. 2011, Peacock et al. 2016, Peacock et al. 2018) and extensive USACE based survey efforts within the Big Sunflower and Yazoo system extending from 1987 through 2000 (Miller et al. 1992, Miller and Payne 1995, Miller and Payne 2004) (Figure 2, Table 1). The “Miller era” efforts in the Big Sunflower includes 65 additional stations extending from Ruleville, Mississippi (Sunflower County) downstream to Holly Bluff Cutoff (Yazoo County), with several stations sampled repeatedly during the survey period. Lastly, ERDC conducted survey efforts in 2020 at 20 additional stations, primarily in the southern extent of the Yazoo Study Area using a mussel sled (*sensu* Miller et al. 1989) (Figure 2, Table 2).

2.1.9 Fat Pocketbook

Description

Fat Pocketbook (*Potamilus capax)* is a moderate-sized mussel with a highly inflated, obovate or globose shell. Shell thickness varies with age, being thin in juveniles and becoming thicker in older individuals. The shell is generally smooth, usually with no rays, and color ranges tan,

yellowish brown, chestnut or greenish brown. Nacre coloration is creamy-white to white or pink tinged. The hinge line possesses a distinctive "s"-shaped" profile with the umbo positioned prominently above the hinge line (Cummings and Mayer 1992, Oesch 1995, Jones et al. 2019, Watters et al. 2009).

Taxonomic Status

The Fat Pocketbook is a freshwater mussel of the family Unionidae occurring in the Ohio and Mississippi river systems within the central U.S. (Watters et al. 2009). It was listed as endangered by the USFWS in 1976, a recovery plan was developed in 1985, revised in 1989 (USFWS 1976, 1989), and status reviews were published in 1987, 1991, and 2012 with no proposed changes recommended (USFWS 2012a).

Two shell morphotypes exist in the Ohio River with a thin-shelled, smaller form and a larger, thick-shelled form. A range-wide morphological evaluation coupled with a corresponding genetic analysis indicated no morphological divergence among Ohio River populations although there was significant genetic divergence between the Ohio and St. Francis river populations (USFWS 2012a).

Habitat Requirements

Specific habitat conditions vary geographically throughout its range, however the Fat Pocketbook generally occurs in sand, mud and silt substrates, typically in slow flowing waters of moderate to large-sized rivers (USFWS 2012a). Like most freshwater mussels, the Fat Pocketbook, is generally regarded as sessile in nature, exhibiting little lateral movement (Williams et al. 2008, Haag 2012). Consequently, the low mobility of mussels may affect long-term survivorship when faced with environmental hardships as individuals are unable to flee immediate threats (Peck 2010). However, based on long-term field trials in the St. Francis watershed (Arkansas), Fat Pocketbook exhibited the capacity to move 100 meters annually, primarily in a downstream direction. The extent of movement is likely linked to the substrate conditions within the waterway (i.e., low stream gradient and unconsolidated substrate) compared to other systems with higher flow and substrate consisting of a gravel, clay and sand mixture (Peck et al. 2014). Critical habitat for the species has not been designated.

Maximum shell length is approximately 150 millimeters (McMurray et al. 2012). Miller and Payne (2005) presented demographic data for a population in the St. Francis watershed, presumed largest population of the species (USFWS 2012a) incorporating over 2000 individuals in their assessment. Size ranged from 10 to 145 millimeters shell length (SL) with 70% between 75 and 110 millimeters SL. Their demographic assessment suggested a low but relatively steady annual recruitment, high longevity and a moderately low annual mortality.

The species is noted as bradytictic (long-term brooder) (Harris and Gordon 1990, Watters et al. 2009) although Peck (2010) comments that is a short-term brooder (tachytictic). Gravid individuals have been observed from June through December (Baker 1928, Cummings and Mayer 1993). The Freshwater Drum (*Aplodinotus grunniens*) is the only known fish host for the species (Barnhart and Roberts 1997).

Range and Population Level

Within Mississippi, the species is restricted to the Mississippi River, particularly secondary channels and chutes, and the Yazoo drainage with relict specimens observed in Sharkey County on the Big Sunflower River (Figure 3; Jones et al. 2019). The largest population likely occurs in the St. Francis drainage in Arkansas (Miller and Payne 2005), although populations are expanding within the Ohio River (USFWS 2012a). Local populations in Mississippi are rarely encountered in high abundances; however, based on the number of fresh valves observed (e.g., fresh dead *sensu* Haag and Warren 1998) a large population exists at Gilliam Chute in Jefferson County, Mississippi (Killgore et al. 2014) and may serve as a source for local recruitment in the LMR. Within the Yazoo Study Area, the Fat Pocketbook mussel is noted from a single location on the Big Sunflower River in Sharkey County (Figure 4). Two individuals were collected in 2004 above Cypress Bend and are represented by relict shells (MMNS 8589, Figure 5). A more detailed account for the species including the LMR population is included in Killgore et al. (2014).

Effects Analysis

The primary causes for population declines are navigation and flood control activities (e.g., impoundment, channel maintenance, dredging; USFWS 1989). The species was formerly widespread throughout the Mississippi River Valley (Killgore et al. 2014, Figure 3) but has experienced greater than 70% reduction of its historic range (NatureServe 2020). Extirpated populations are presumed to have been directly affected by impoundments and dredging or these activities may have indirectly affected populations by affecting fish host habitat associations (USFWS 2012a). Additional threats to current populations include hydropower and hydrokinetic operations, sedimentation, increased turbidity levels, water quality degradation and non-point source pollution (USFWS 2012a). However, populations appear to be stable where it currently occurs (St. Francis, Wabash, Ohio and Lower Mississippi rivers). Critical habitat for the species has not been designated.

Recovery objectives require protection of the St. Francis River population, and location and protection of at least two additional viable populations in two other river systems within the historical range of the species. The Ohio River population has expanded in recent years, and a population has been discovered in the LMR. Both new populations are considered viable, based on the presence of juvenile and subadult specimens. Neither range nor population size of the Fat Pocketbook have been defined or quantified in the Ohio and LMR; however, both populations are considered by state and federal agencies during regional project reviews and evaluations, and are protected to some degree through formal and informal consultations (USFWS 2012a).

Efforts to provide supplemental stream flows (i.e., e-flows) within the basin during current low flow situations experienced during August to October with the supplemental low flow groundwater wells will improve habitat condition and survivability of both fishes and mussels (direct and indirect) but will not benefit Fat Pocketbook since there are no extant populations within the watershed.

Conclusions and Determinations of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Fat Pocketbook. Fat Pocketbook historically occurred within the Yazoo Study Area but no extant populations are currently known within the Yazoo Study Area. Recent survey efforts at 20 stations failed to document any federally listed mussel species within the lower extent of the Yazoo Study Area, supporting results of previous survey efforts (Table 2). LMR populations of Fat Pocketbook near the Yazoo Study Area appear to be stable (USFWS 2012a). Within the LMR, over the course of routine monitoring for fishes, mussels and benthic macroinvertebrates within secondary channel habitats, Fat Pocketbook mussels are frequently observed (Slack personal observation). Consequently, nearby populations are not likely to be impacted by the Proposed Plan.

2.1.10 Rabbitsfoot

Description

The Rabbitsfoot (*Theliderma cylindrical*) is a medium to large-sized mussel with a thick and solid shell. The shell profile is elongate, rhomboid or rectangular, squared off posteriorly and rounded anteriorly with a compressed, nearly cylindrical appearance. The posterior ridge is well-developed, sometimes with a sulcus, and contains a row of heavy knobs along the ridge extending from the umbo to the posterior margin. A wing extends along the dorsal slope posterior to the umbo, generally with shallow, oblique ridges. The umbo is broad and low, somewhat inflated and extends slightly above the hinge line. Shell sculpture varies from densely pustulose with irregular corrugations to nearly smooth. Shell coloration is yellowish-green to brown, usually becoming darker with age. The surface typically has numerous dark olive chevrons which may change to rays or streaks in some populations. Pustules in younger individuals may be lighter colored. The nacre is porcelain white, often iridescent posteriorly (Parmalee and Bogan 1998, Williams et al. 2008, Watters et al. 2009, Jones et al. 2019).

Taxonomic status

Two subspecies, *Theliderma* (*Quadrula*) *cylindrica cylindrica* and *T. c. strigillata* (Rough Rabbitsfoot) have been recognized based primarily on differences in shell morphology with the Rough Rabbitsfoot primarily confined to the headwaters of the Tennessee River in east Tennessee (Parmalee and Bogan 1998). Williams et al. (2017) recently synonymized both taxa under *Theliderma cylindrica* (Rabbitsfoot) citing that the shell forms noted for both subspecies represented ecophenotypic variation and that molecular assessments lacked support for recognizing *T. c. strigillata* as a subspecies.

The Rabbitsfoot is a freshwater mussel of the family Unionidae occurring the Ohio, Cumberland and Tennessee river systems, western Lake Erie drainages and LMR drainages from Louisiana and Mississippi north to Missouri and west to Kansas (Parmalee and Bogan 1998, Williams et al. 2008, Watters et al. 2009). The Rough Rabbitsfoot historically occurred in the Powell, Clinch, North Fork and South Fork of the Holston River in northeastern Tennessee and southwestern Virginia. Its current distribution is limited to reaches of the Powell and Clinch Rivers (USFWS 2007).

The Rough Rabbitsfoot was listed as endangered by the USFWS in 1997 and the nominal form (*Theliderma c. cylindrica*) was listed as threatened in 2013 (USFWS 1997, 2013). A recovery

plan for the Rough Rabbitsfoot was finalized in 2004 (USFWS 2004). A recovery plan for the Rabbitsfoot (*Theliderma c. cylindrica*) has not been developed.

Range and population level

In Mississippi, the species occurs in the Tennessee, Yazoo and Big Black drainages (Figure 6, Jones et al. 2019). The Rabbitsfoot was likely more widespread throughout the Yazoo drainage based on available archaeological material (Figure 6, 7) but the only extant population within the drainage occurs in the Big Sunflower River in the reach between Indianola and Ruleville (Sunflower County).

Populations of the Rabbitsfoot have declined across its range due primarily to impoundments in large river systems. The Rabbitsfoot was historically known from 139 streams throughout its range and 15 states. It was considered widespread and locally abundant in most systems. Researchers began noting a decline in abundance during the early 1970's and a severe reduction in the range of the Rabbitsfoot since that time. It is currently extant in 46 streams in 13 states. The current range represents a 66% reduction from its historic extent. Extant populations are typically highly fragmented and restricted to short reaches. The status of extant populations have been grouped into three categories: 1) sizable populations with ample evidence of recent recruitment and currently considered long-term viable for several decades to come; 2) small populations with limited levels of recent recruitment, generally highly restricted in distribution, of doubtful or limited viability, and susceptible to extirpation in the foreseeable future; and 3) marginal populations that are considered very rare, with no evidence of recent recruitment, of doubtful viability, and may be on the verge of extirpation in the immediate future. Sizable populations includes 10 streams while small (20) and marginal populations (16) comprise the greatest number of systems (78%). Mississippi populations of Rabbitsfoot are included in the small population category (Butler 2005).

The population in the Big Sunflower River appears stable. Observations reported in Butler (2005) for the system in the early 2000's noted several live and fresh dead specimens at multiple sites along the river reach in Sunflower County upstream of Indianola. Biologists with ERDC conducted routine sampling for fishes, mussels, and benthic macroinvertebrates annually at numerous stations on the Big Sunflower River from 2014 to 2017, including many of the same sites for the early 2000 observations (Slack, personal communication). During this period Rabbitsfoot were observed at five stations and represented 71 total individuals (2014 (n= 4, fresh dead), 2015 (n=29, 22 live or fresh dead), 2016 (n=23, 19 live or fresh dead) and 2017 (n=15, fresh dead)). Shell lengths on live individuals were taken in the field and the specimens then returned to the point of original capture. Size of processed mussels was similar across years suggesting some level of recruitment within the system (Slack, personal observation). Other Mississippi populations (Bear Creek, Tennessee drainage and Big Black River, Mississippi River drainage) are small with the species being relatively uncommon (Butler 2005, Jones et al. 2019).

No recent specimens have been reported from the Yazoo Study Area although archaeological material from along the periphery of the Yazoo Study Area indicates it once occurred within the region (Figure 7, Peacock et al. 2011).

Habitat Requirements

The Rabbitsfoot mussel occurs in large creeks to large rivers, in shallow water often along margins of shoals in sand/gravel substrate in slow to moderate current. It may also be found in greater depths (9 to 12 feet) but with current. Individuals are often observed unburied along the water's edge but noted to bury during drought conditions (Parmalee and Bogan 1998, Williams et al. 2008, Watters et al. 2009). In the Big Sunflower River during low flow conditions in September 2015, Rabbitsfoot were observed generally near-shore in a sand/gravel substrate mixture with some mud. Mean water depth was 0.41 feet and surface velocity averaged 16.5 cm/sec (Slack, personal communication). Critical habitat designation for the Rough Rabbitsfoot was released in 2004 (USFWS 2004) and critical habitat was designated in 2015 for the nominal form, Rabbitsfoot. Critical habitat in the Yazoo drainage includes 32 river miles of the Big Sunflower River from Mississippi Highway 442 west of Doddsville downstream to the Quiver River confluence east of Indianola (Sunflower County).

Data for demographics, age and longevity are limited for the Rabbitsfoot mussel. Watters et al. (2009) indicates a shell size up to 130 millimeters. Fobian (2007) noted shell length of brooding females in an Arkansas population of Rabbitsfoot ranged from 82 to 122 millimeters and age estimates were 6 to 17 years. Similarly, Yeager and Neves (1986) aged female Rough Rabbitsfoot by counting external growth rings. Individual had a shell length 81 to 102 millimeters and corresponding ages ranged 10 to 22 years. Additional data suggests individuals may live up to 63 years (Butler 2005). Demographic data for the Big Sunflower River population (Figure 8) illustrates multiple size classes ranging 54.9 to 101.9 millimeters with a mean shell length of 79.3 millimeters; no corresponding age data are currently available.

The Rabbitsfoot is a short-term brooder (tachytictic) being gravid from June to August (Watters et al. 2009). Fobian (2007) noted the species exhibits seasonal movement migrating toward shallower water during brooding periods occurring between May and late August in the upper Arkansas, White, and Red river systems. Individuals reach sexual maturity at 4 to 6 years. Glochidia are released in August in the form of tan to orange lancelate conglutinates (Butler 2005). Fish hosts for the Rabbitsfoot include Rainbow Darter (*Etheostoma caeruleum*) and Striped Shiner (*Luxilus chrysocephalus*) (Watters et al 2009). Additional investigations noted Blacktail Shiner (*Cyprinella venusta*), Cardinal Shiner (*Luxilus cardinalis*), Red Shiner (*C. lutrensis*), Spotfin Shiner (*C. spiloptera*), Bluntface Shiner (*C. camura*), Carmine Shiner (*Notropis percobromus*), and Emerald Shiner (*N. atherinoides*) served as hosts for Rabbitsfoot in Arkansas streams (Fobian 2007). Hosts for Rough Rabbitsfoot include Whitetail Shiner (*Cyprinella galactura*), Spotfin Shiner (*C. spliloptera*), and Bigeye Chub (*Hybopsis amblops*) (Yeager and Neves 1986). Many of these species or closely related congeners occur within the Yazoo Drainage (Ross 2001).

Effects Analysis

The impacts of dams to fluvial systems has been well documented (Baxter 1977, Watters 1996, Vaughn and Taylor 1999) and may further impact fish passage thereby limiting critical mussel-fish host interactions (Haag 2012). Population losses due to impoundments have likely contributed more to the decline of the freshwater mussels, including the Rabbitsfoot, than any other factor. These efforts have effectively converted continuous reaches of suitable riverine habitat into short, isolated patches leaving large river populations existing as small metapopulations, seemingly fragmented by locks and dams separated by deep uninhabitable,

pools of water (USFWS 2013). Most lotic or fluvial oriented mussels, including the Rabbitsfoot, generally do not thrive in reservoirs that lack riverine characteristics. They are unable to successfully reproduce and recruit under these conditions. Furthermore, conversion of habitat from lotic to lentic conditions often results in a similar shift in fish assemblages following in the loss or lack of suitable fish hosts for relict mussel populations (Bogan 1993).

The impacts of sedimentation and chemical contaminants on Rabbitsfoot are similar to the concerns presented for the Sheepnose mussel. Similarly, the Rabbitsfoot releases its glochidia as a conglutinate which mimics food items of the host fish and depends on the visual acuity of the host to facilitate glochidia uptake (Barnhart et al. 2008). Within the Big Sunflower River, additional impacts include agricultural runoff and sedimentation from intensive row-cropping, and pumping groundwater for irrigation, which is lowering the water table and decreasing flow rates in the river (Butler 2005).

Large river populations have been affected in some cases by Zebra Mussel (*Dreissena polymorpha*) infestations (Butler 2005). Impacts to Rabbitsfoot in the Yazoo drainage is minimal to non-existent as the Zebra Mussel currently does not occur in that system (Benson et al. 2020). Lastly, small isolated populations are likely more prone to further extirpation from stochastic events, such as severe drought, chemical spills, or unauthorized discharges (USFWS 2013).

Recovery criteria for the Rough Rabbitsfoot are listed below (USFWS 2004). A similar list of criteria would likely be implemented for Rabbitsfoot:

> Downlisting from endangered to threatened status will occur when the following criteria are met for the protection of extant stream populations, discovery of currently unknown stream populations, and/or reestablishment of historical stream populations: (1) three streams with distinct viable populations of the Rough Rabbitsfoot have been established; (2) one distinct naturally reproduced year class exists within each of the viable populations; (3) research studies of the mussels' biological and ecological requirements have been completed and any required recovery measures developed and implemented from these studies are beginning to be successful, as evidenced by an increase in population density of approximately 20% and/or an increase in the length of the river reach of approximately 10% inhabited by the species as determined through biennial monitoring; (4) no foreseeable threats exist that would likely impact the survival of the species over a significant portion of their ranges; (5) within larger streams the species are distributed over a long enough reach that a single catastrophic event is not likely to eliminate or significantly reduce the entire population in that stream to a status of nonviable; and (6) biennial monitoring of the five species yields the results outlined in criterion (1) above over a 10-year period.

Efforts to provide supplemental stream flows (i.e., e-flows) within the basin during current low flow situations experienced during August-October with the supplemental low flow groundwater wells will improve habitat condition and survivability of both fishes and mussels through direct and indirect impacts. The timing of proposed supplemental flows corresponds with the glochidia release period in short-term brooders which includes the Rabbitsfoot which is the critical stage

for fish host infestation. Additional flows during this period will provide greater potential for fish movement and potentially promote expansion of the Rabbitsfoot into previous unexploited habitat within the system.

Conclusions and Determination of Effects
The Proposed Plan may affect, but is not likely to adversely affect the Rabbitsfoot. The Rabbitsfoot historically occurred near the Yazoo Study Area but no extant populations are currently known within the Yazoo Study Area.

Dense mussel beds occur below one lock and dam on the Big Sunflower River (river mile 62) Lock and Dam No. 1 with Threeridge (*Amblema plicata*) being the dominant species (Miller and Payne 1995, 2004). Extensive sampling conducted in the impounded reach from Lock and Dam No. 1 upstream to Ruleville, Mississippi (RM 62-149.2) documented 25 species with Rabbitsfoot limited to the reach upstream of Indianola where habitat suitable for the species is more prevalent (Miller and Payne 1995). Eight species were common throughout the reach and occurred at more than half the sampled stations (*Plectomerus dombeyanus*, Bankclimber; *Amblema plicata*, Threeridge; *Lampsilis teres*, Yellow Sandshell; *Potamilus purpuratus*, Bleufer; *Pyganodon grandis*, Giant Floater; *Cyclonaias pustulosa*, Pimpleback; *Glebula rotundata*, Round Pearlshell; and *Megalonaias nervosa*, Washboard). Though fish passage over the non-functional lock structure may be problematic during low flow periods, evaluation of survey efforts along with mussel occurrence and abundance patterns suggests Lock and Dam No. 1 has had little impact on the mussel assemblage within the Yazoo Study Area. Host species for the Rabbitsfoot are small-bodied fishes that generally have limited home ranges and do not exhibit long-distance migration events. Thus, Lock and Dam No. 1 has no likely impact on this federally listed species occurring within the reach between Indianola and Ruleville, Mississippi.

2.1.11 Sheepnose

Description
The Sheepnose (*Plethobasus cyphyus*) is a medium to large-sized mussel with an elliptical to quadrate, slightly inflated shell and a shallow sulcus. The shell is thick and has a smooth surface that may contains round to oblong pustules or knobs oriented along the middle of the shell near the anterior margin of the sulcus extending from the umbo to the ventral margin. Shell color ranges yellowish-brown in young specimens to dark reddish-brown in adults with black coloration concentrating more on the anterior surface and umbo. Nacre coloration is white with a slight iridescent tone along the posterior margin. The umbo is wide and prominent extending high above the hinge line. Specimens are generally without rays (Parmalee and Bogan 1998, Williams et al. 2008, Watters et al. 2009, Jones et al. 2019).

Taxonomic status
The Sheepnose is a freshwater mussel of the family Unionidae occurring in the Mississippi River basin from Minnesota and Wisconsin downstream to northern Mississippi (Williams et al. 2008). The Mississippi population lies at the most southern extent of the species range (Jones et al. 2005). Within the Ohio River basin, it is found in the Ohio, Tennessee and Cumberland river systems (Watters et al 2009). A status assessment was prepared in 2002 (Butler 2002) noting that extant populations were generally small and geographically isolated. The species was listed

as endangered by the USFWS in 2012 (USFWS 2012b). A recovery plan has not been developed.

General shell morphology varies with age and river system but no distinct differences have been noted. Genetic analyses indicate extant populations appear to be genetically isolated from each other suggesting that each population be managed as independent entities for proposed conservation measures (USFWS 2012b). Schwarz (2018) conducted genetic assessment of populations across the Midwestern U.S. and reported that populations had a high degree of genetic diversity but two distinct populations were evident based on genetic structure (Upper Mississippi River and Ohio River basins). Additionally, genetic data support low rates of migration between populations within a drainage basin but not between basins.

Range and Population Level

In Mississippi, the species is known only from the Yazoo and Big Black drainages (Figure 9, Jones et al. 2019). It was likely more widespread throughout the Yazoo drainage based on available archaeological material (Figure 10) but currently the only extant population occurs in the Big Sunflower River in the reach between Indianola and Ruleville (Sunflower County). Variable sized individuals observed during past survey efforts within the reach along with a fresh dead shell of juvenile suggests some level of recruitment, but there is uncertainty on the size of the Big Sunflower population (Butler 2002, Jones et al. 2019). Historically, the Sheepnose was fairly widespread, although rarely very common. Evidence from archaeological middens provides additional support of it is rarity. The species now exists as small, fragmented and geographically isolated populations (Butler 2002). The Meramec River (Missouri) likely maintains the largest population rangewide, although there has been a reduction in length of the corresponding river reach harboring this population over the past 40 years (Butler 2002). No recent specimens have been reported from the Yazoo Study Area although archaeological material from along the periphery of the Yazoo Study Area indicates it once occurred within the region (Figure 10, Peacock et al. 2011).

Habitat Requirements

The Sheepnose typically occurs in flowing waters of larger rivers and streams. Within unimpounded river reaches, the mussel may be found in shallow shoals in relatively fast current in less than two feet of water. Water depth ranges 12 to 15 feet in reservoirs and dam tailwaters where the species is found. Substrate is generally a mixture of coarse sand and gravel, occasionally sandy mud (Oesch 1995, Parmalee and Bogan 1998, Williams et al. 2008, Watters et al. 2009). Habitat in the Big Sunflower River features a mixture of clay and gravel in flowing water (Jones et al. 2019). Critical habitat for the species has not been designated.

Little data are available on demographics, age, and longevity. Watters et al. (2009) indicates a shell size up to 130 millimeters and a corresponding age of 30. Hove et al. (2015) noted specimens observed for brooding behavior studies ranged in age between 4 and 30 years (Chippewa River, Wisconsin). Butler (2002) commented that one individual from the Meramec River (Missouri) was 21 to 25 years old based on a count of external growth rings. Thick-shelled, large river forms, such as the Sheepnose, are believed to live longer than other freshwater mussel species (Stansbery 1961).

The Sheepnose is a short-term brooder (tachytictic) with most reproduction occurring in early summer (Parmalee and Bogan 1998). Williams et al. (2008) noted individuals are gravid from May to July. Hove et al. (2015) found individuals gravid from mid-May to early August in Wisconsin and ranged in age from 5 to 26 years. Central stoneroller (*Campostoma anomalum*) and Sauger (*Sander canadense*) have been noted as fish hosts for the species (Parmalee and Bogan 1998, Williams et al. 2008, Watters et al. 2009); however, others (Guenther et al. 2009, Wolf et al. 2012) later noted nearly 30 species in four families (Cyprinidae, Fundulidae, Poeciliidae and Percidae) have been identified as fish hosts. Hove et al. (2015) conducted laboratory and field trials to test fish host specificity for Sheepnose and determined that the species is probably a cyprinid specialist and it employs a host generalist glochidia release behavior to passively entangle host species.

Effects Analysis

The causes for decline include habitat loss and degradation as the result of impoundments, channelization, chemical contaminants, mining, and sedimentation (Butler 2002, USFWS 2012b). These aspects directly impact freshwater mussels by altering suitable habitat conditions and indirectly by altering associated fish assemblages thereby potentially impacting fish host availability (Haag 2012, Haag and Williams 2014).

Population losses due to impoundments has likely contributed more to the decline and imperilment of the Sheepnose mussel than any other factor. Impounding large river habitat results in short, isolated patches of suitable habitat generally in the area immediately downstream of dams (USFWS 2012b). The Sheepnose mussel has been eliminated from 2/3 of its historic range resulting in small and geographically isolated populations that are susceptible to extirpation from a single catastrophic event (Butler 2002).

Sediment input into streams is a major problem in most U.S. waters (Waters 1995) directly impacting freshwater mussel populations (Brim Box and Mosa 1999, Nobles and Zhang 2011). Additional sediment loads within a stream system can reduce feeding and respiratory efficiency (Brim Box and Mosa 1999). Similarly, increased turbidity levels may affect visual effectives for sight-feeding host fishes resulting in a reduction in reproductive potential for mussels employing a luring reproductive strategy (Haag 2012). Increased sedimentation, particularly fine sediments, may lower the adhesiveness of glochidia mucus strands or smother the strands altogether (Hove et al 2015). In addition, fine sediments can fill interstitial spaces necessary for successful juvenile mussel recruitment (Brim Box and Mossa 1999). The Sheepnose mussel utilizes a glochidia broadcast strategy (e.g., glochidia mucus strand) and Hove et al. (2015) posits the species may have declined more rapidly than other glochidia broadcasters (e.g. *Amblema plicata*, *Megalonaias nervosa*) because of its cyprinid host specificity and the corresponding shifts in their abundance due to changes within river system.

Impacts from chemical contaminants (point source) to Sheepnose populations are generally more isolated to specific river systems and tend to have an immediate, but lasting effect on local populations. Non-point source contaminants generally do not have an immediate impact on populations but rather express themselves as long-term legacy effects (Butler 2002).

No specific recovery objectives have been identified although general directives have been noted and include, in part, expanded survey efforts to better define and update river specific status; evaluate relocation practices; improve propagation techniques; investigate life history components including host fish relationships; monitor habitat conditions and implement best management practices to reduce sedimentation and runoff; initiate habitat restoration programs; reduce impacts of mining; and promote increased public outreach and education (Butler 2002, USFWS 2012b).

Conclusions and Determination of Effects

The Proposed Plan may affect, but is not likely to adversely affect the Sheepnose. Currently, no extant populations occur within the Yazoo Study Area. The nearest population occurs more than 20 river miles upstream of the northern boundary of the Yazoo Study Area in a reach of the Big Sunflower between Indianola and Ruleville, Mississippi (Sunflower County). Recent survey efforts at 20 stations failed to document any federally listed mussel species within the lower extent of the Yazoo Study Area supporting results of previous survey efforts (Table 2), which found no populations in the LMR near the Yazoo Study Area (USFWS 2012b).

Additionally, populations outside of the Yazoo Study Area are not likely to be impacted by the Proposed Plan due to the sessile nature of the species and limited migration behaviors of host fish species. Fish passage through Lock and Dam No. 1 at river mile 62 on the Big Sunflower River can be problematic during low flow periods but may be possible during higher flows. Yet, host species for the Sheepnose are small-bodied fishes with limited home ranges that do not exhibit long-distance migration behavior. The Sauger (*Sander canadense*), a confirmed Sheepnose host, is the only species that may conduct long-distance migrations within the system, however it has not previously been reported in the Yazoo drainage (Ross 2001).

3.0 ADDITIONAL SPECIES

3.1 Indiana Bat

The threatened Indiana Bat (*Myotis sodalis*) is a federally listed bat species that utilizes forest and forested wetland habitats, where they are known to roost in tree cavities, exfoliated bark and snags. The Indiana Bat was not listed for the project footprint according to the IPaC website, therefore the Proposed Plan is anticipated to have no effect on the Indiana Bat.

3.2 Whooping Crane

The Whooping Crane (*Grus americana*) (eastern population) is another federally listed species that has a very low likelihood of occurrence in the Yazoo Study Area. The Whooping Crane is not listed in the USFWS Mississippi List of Federally Threatened and Endangered Species by County found on the USFWS Mississippi Ecological Services Field Office website (https://www.fws.gov/MississippiES/_pdf/MS%20TE%20County%20List_2019final.pdf). The Whooping Crane occupies open wetlands and grasslands during migration, and is likely only to be present as a rare transient (Urbanek and Lewis 2020). Again, such habitats are unlikely to be impacted therefore the Proposed Plan is anticipated to have no effect on the Whooping Crane.

3.3 Louisiana Black Bear

The Louisiana Black Bear was removed from ESA protection in 2016, and is therefore not a concern as a federally listed species in 2020. The USACE (2007b) Biological Assessment detailed projected impacts on this species within the Yazoo Study Area, concluding that bears would largely be unaffected by the proposed plan. Although there are four known denning sites in the Delta National Forest, only 112 acres of bottomland forests are targeted for removal during construction of the pump project, and no signs of bear use in this area were recorded during surveys in 2007 (USACE 2007b). Fifteen black bears in the MAV were tagged and studied for den use and chronology between 2005 and 2011 (Waller et al. 2012), which likely included bears in the Yazoo Study Area. Therefore, number of bears currently using habitats in the Yazoo Study Area may be more than the four bears mentioned in the USACE (2007b) report. In addition, reforestation efforts through mitigation as part of the Proposed Plan would improve future habitat availability for this species. Moreover, most forested land in the Yazoo Study Area is in both public and private land ownership or conservation easements and is unlikely to change in the future. With the exception of land protected under the Wetland Reserve Program, land uses in the Yazoo Basin have remained relatively unchanged since the 1980's; therefore, forested habitats should remain stable or increase for this species (USACE 2007b). Black bears may be negatively impacted by flooding, especially during the breeding season (Waller et al. 2012). However, by maintaining inundation at or near 87 feet, NGVD, impacts to black bears should be reduced (USACE 2007b). It is important to note that black bears can benefit significantly from the presence of increased forested habitat or the addition of forested corridors linking forested habitat blocks in the landscape (Pelton 1982). Targeted mitigation sites for replanting to hardwoods should focus on those areas that will increase forest interior core areas and those that provide linkages between and among large tracts of forests.

3.4 Bald Eagle

The Bald Eagle, formerly federally protected under ESA but now delisted, is found in the Yazoo Study Area, especially during the winter. Although no longer federally protected by the ESA, this species is still protected under the Bald and Golden Eagle Protection Act (1962). No direct, indirect, or cumulative adverse impacts to the Bald Eagle are expected from the construction and operation of the Proposed Plan. Bald Eagles are a rare and unlikely breeder in the Yazoo Study Area, though as populations continue to expand nationally and regionally, future Bald Eagle nesting in or near the Yazoo Study Area is possible. USFWS guidelines suggest construction should not occur within 0.5 mile (2,640 ft.) of any eagle nests during the time of egg-laying, incubation, and the first month after hatching (01 October to 15 May). If a bald eagle nest occurs or is discovered within 660 ft. of the proposed work location, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. Verification of the absence of nesting bald eagles could ensure construction would not directly, indirectly, or cumulatively have adverse impacts on Bald Eagles.

4.0 EFFECTS OF SUPPLEMENTAL LOW FLOW GROUNDWATER WELLS

As discussed above, supplemental stream flows (i.e., environmental flows or e-flows) within the basin during current low flow situations experienced during August-October will improve condition and survivability of endemic fishes, mussels (Rabbitsfoot), and macroinvertebrates

(EPT indicator taxa (The EPT is named for three orders of aquatic insects that are common in the benthic macroinvertebrate community: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). The EPT Index is based on the premise that high-quality streams usually have the greatest species richness.)). Environmental flows should be achieved by installation and operation of approximately 34 supplemental low flow groundwater wells. The overall goal for the supplemental low flow groundwater wells is to return the Yazoo Basin to its historical observed low flow state of the twentieth century. Maintaining natural flow regimes is critically important to aquatic systems because it (1) determines physical habitat within streams which affects biotic composition; (2) accommodates aquatic species that have evolved life history strategies in sync with natural flow regimes; and (3) promotes maintenance of natural patterns of longitudinal movement within the system and connectivity to floodplains and wetlands that are essential to many riverine species (Bunn and Arthington 2002). The supplemental low flow groundwater wells will ideally contribute an increase of 0.1 to 0.3 cfs per square mile for each watershed in the Big Sunflower, Deer Creek, Steele Bayou basins. This increase in watershed yield will utilize up to 5 cfs per well or up to 150 cfs discharged to main stem Big Sunflower River. This increase in flow should provide adequate surface water (i.e., wetted surface) to keep the mussel beds inundated during criterial low flow conditions. Additionally, increased permanent surface flows will maintain lotic conditions to provide adequate habitat for aquatic insect life cycle completion. Increase in flow from supplemental low flow groundwater wells or baseflow augmentation results in several environmental benefits to stream biota including:

1. Maintenance of the low flow channel (thalweg), improve oxygen dynamics, increase bedform and habitat diversity, as well as increase insect drift and fish migration (Bêche et al. 2009).
2. Increase support and sustainability of resilient aquatic populations and diverse ecosystems in response to improvements in stream geomorphology and bedform diversity (Palmer et al. 2005).
3. Enhancement of a suite of stream functions such as water storage and delayed release, biogeochemical processing and water quality enhancement, carbon export and food chain support, amphibian habitat, amphibian feeding, as well as breeding and refugia for aquatic organisms during high water events and other unfavorable in-stream conditions.
4. Re-establishing higher minimum flows provides benefits to aquatic resources by increasing the area, volume, stability and diversity of aquatic habitats during natural low flow periods (Higgins and Konrad 2012). Biotic responses include increases in diversity and abundance of fishes and mussels (Travnichek et al. 1995, Layzer and Scott 2006), improved condition in affected fishes (Weisberg and Burton 1993), increased spawning success and juvenile survival of fishes (Sabaton et al 2008, Rolls and Wilson 2010), and maintains natural diversity in invertebrate assemblages (Bednarek and Hart 2005, Lind et al 2007).
5. Managed environmental flows during critical low flow periods can mitigate mussel mortality during drought conditions (Allen et al. 2013). Severe reductions in biomass and changes in community composition associated with these events results in a decline in ecosystem services provided by the mussel community (Spooner and Vaughn 2008, Vaughn et al 2015).
6. Extended periods of low flow may cause mussel beds to be exposed to altered temperature regimes with greater mussel mortality occurring in shallower water, although temperature sensitivity varies among species (Galbraith et al. 2010, Galbraith and Vaughn 2011). In addition,

low flow periods may indirectly affect mussels by limiting access of fish host species to mussel beds during critical periods of glochidia release thereby affecting recruitment success (Freeman and Marcinek, 2006, Gido et al. 2010).

7. In a review of published studies, Poff and Zimmerman (2010) highlighted that fish were sensitive indicators of flow alterations with abundance, diversity and demography experiencing declines under both elevated and reduced flow conditions, however decreases were more prevalent under reduced flow regimes.

8. Promoting environmental flows that maintain the annual natural flow regime allows for life cycle completion for aquatic macroinvertebrates, particularly lotic obligate species. Lotic aquatic insects require year-round flow for persistence. Ovipositing females select suitable habitat for their young and deposit eggs in and around flowing water. Developing larvae utilize flowing water for respiration, feeding, and dispersal (Merritt et al. 2018). Periodic loss of flow in rivers is reflected in macroinvertebrate community structure (Harrison 2018, Poff and Ward 1989).

9. Running water hosts the maximum diversity of environmentally sensitive insect taxa, specifically EPT taxa (Ephemeroptera, Plecoptera, Trichoptera), which is due to increased oxygen saturation and cooler temperatures (Merritt et al. 2018). These taxa are amongst the most imperiled freshwater groups worldwide (Master et al. 2000).

10. Freshwater invertebrates provide multiple benefits to the aquatic and terrestrial environments. They are critical components of complex foodwebs and nutrient cycles. In surface water, aquatic invertebrates transform coarse organic matter into fine organic matter, as well as filter particulates in the water column. There, they are prey items for almost all stream fish species. Through their emergence into the terrestrial environment, aquatic insects remove nutrients from the aquatic environment. There, they are food items for birds, bats, and other arthropods, in riparian zones and floodplain forests and beyond (Morse 2009).

Figure 1. Shovelnose sturgeon caught by fisherman in tailwaters of Sardis Reservoir on 23 May 2020 (M. Wagner, MDWFP).

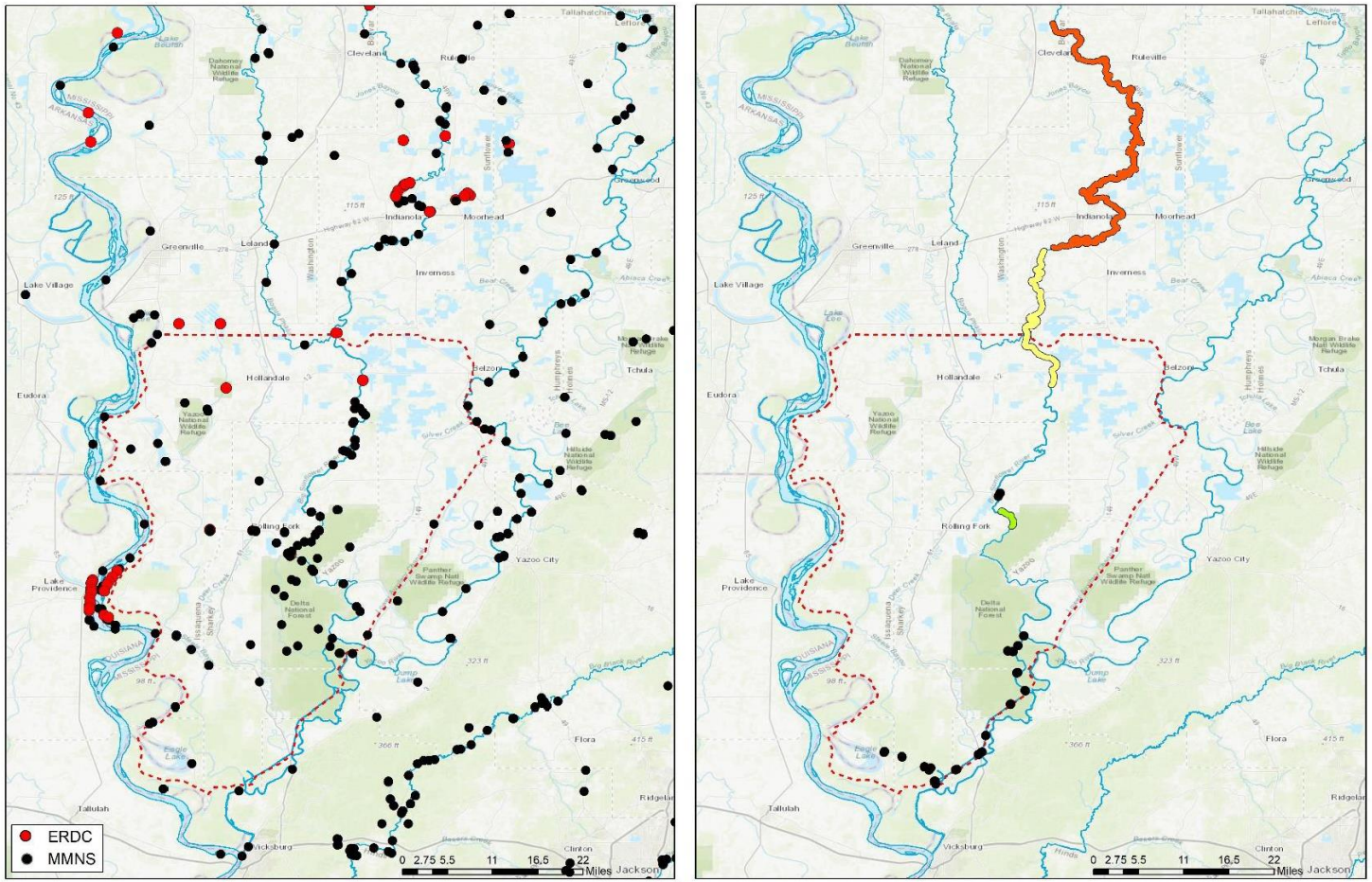

Figure 2. MMNS (black dots) and ERDC freshwater mussel collection records (red dots) for the geographic area encompassing the Yazoo Study Area (red outline) (left panel). Reaches of the Big Sunflower River (green, yellow and red highlight) sampled by Miller et al. (1992), Miller and Payne (1995) and Miller and Payne (2004) along with current locations (black dots) sampled by ERDC using a mussel sled (*sensu* Miller et al. 1989) (right panel).

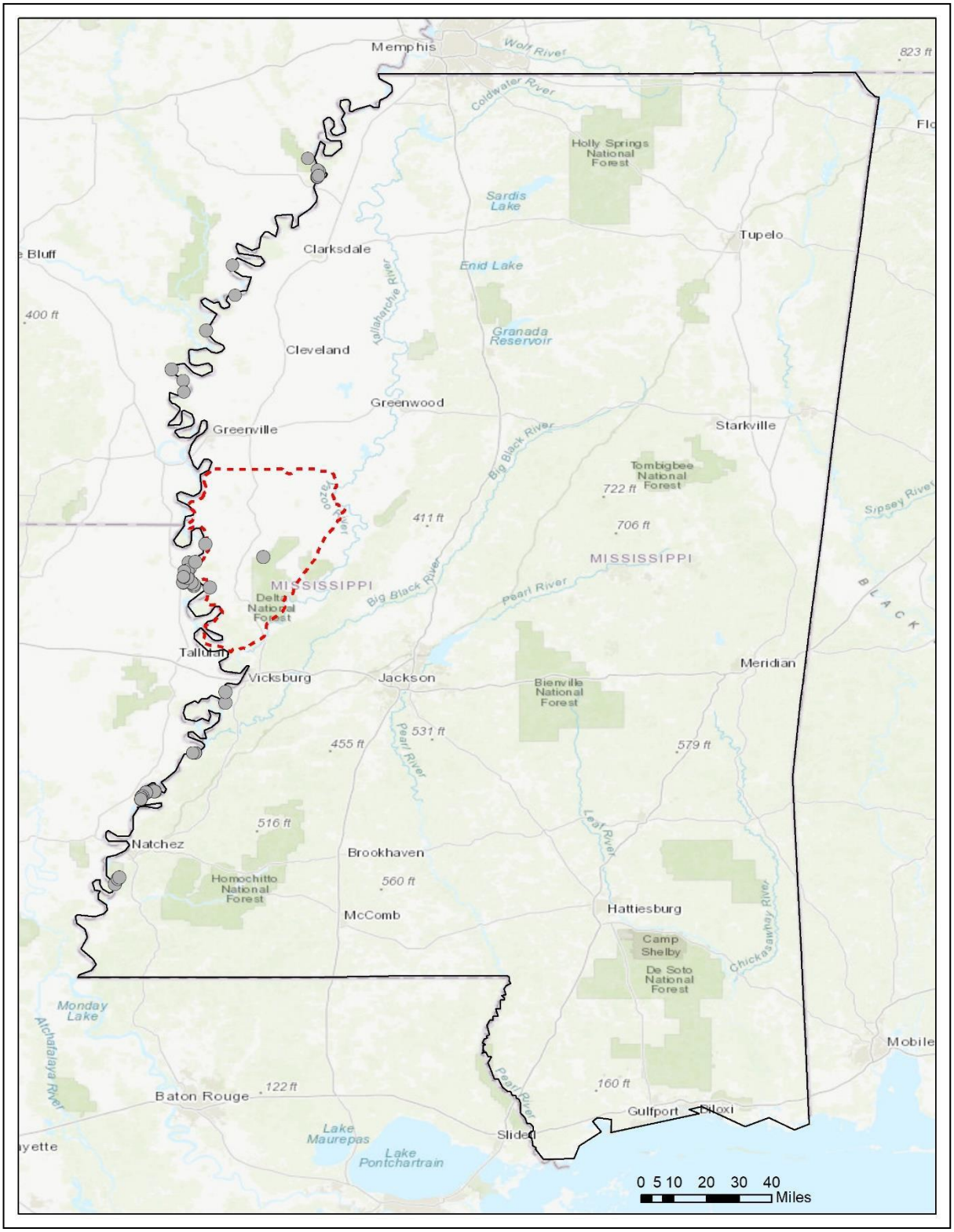

Figure 3. Distribution of the Fat Pocketbook mussel in Mississippi. Grey dots represent recent survey efforts or MMNS records.

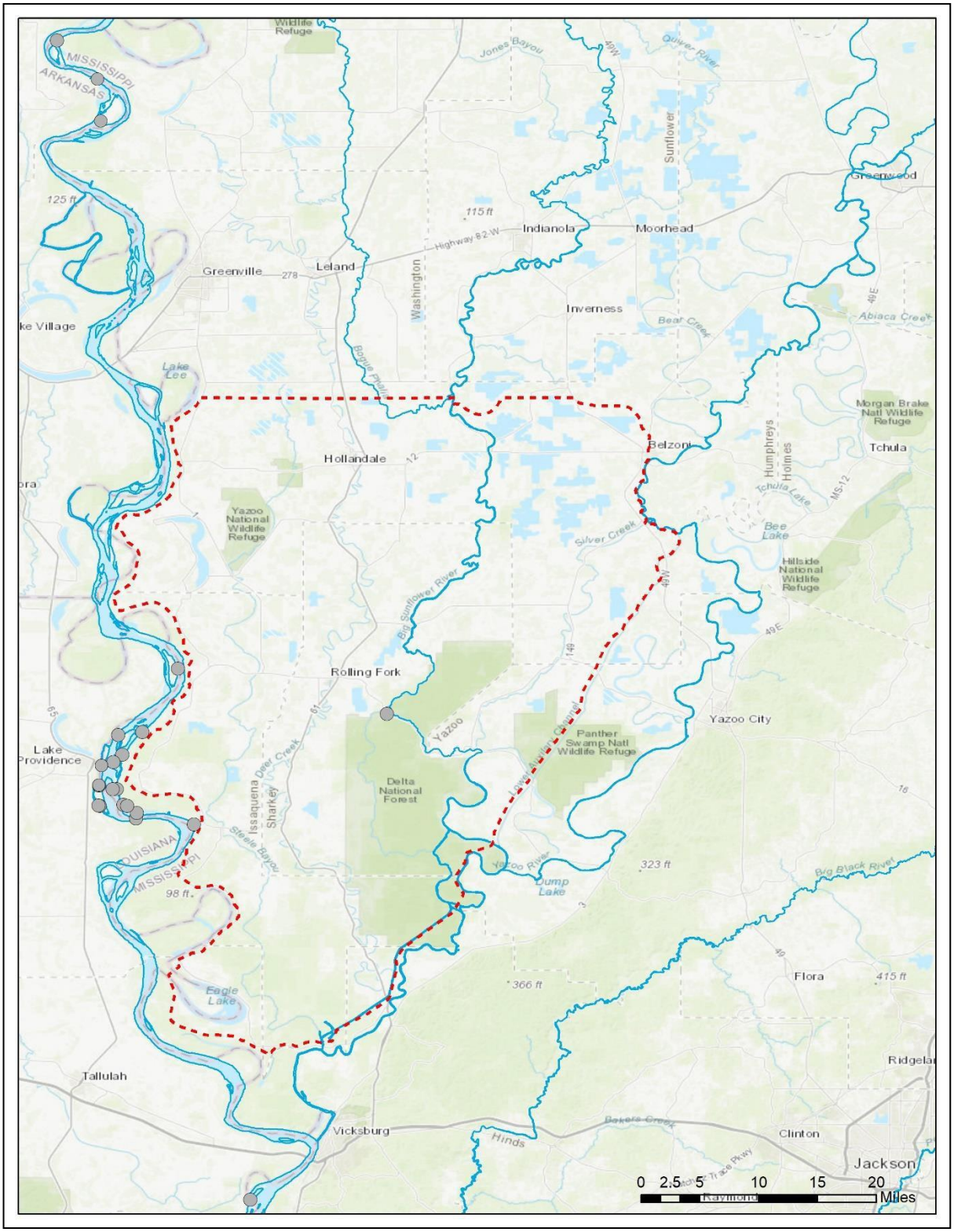

Figure 4. Occurrence of the Fat Pocketbook within the Yazoo Study Area (red outline). Grey dots represent recent survey efforts or MMNS records.

Figure 5. Relict Fat Pocketbook from Big Sunflower River above Cypress Bend, Sharkey County, Mississippi (MMNS 8589).

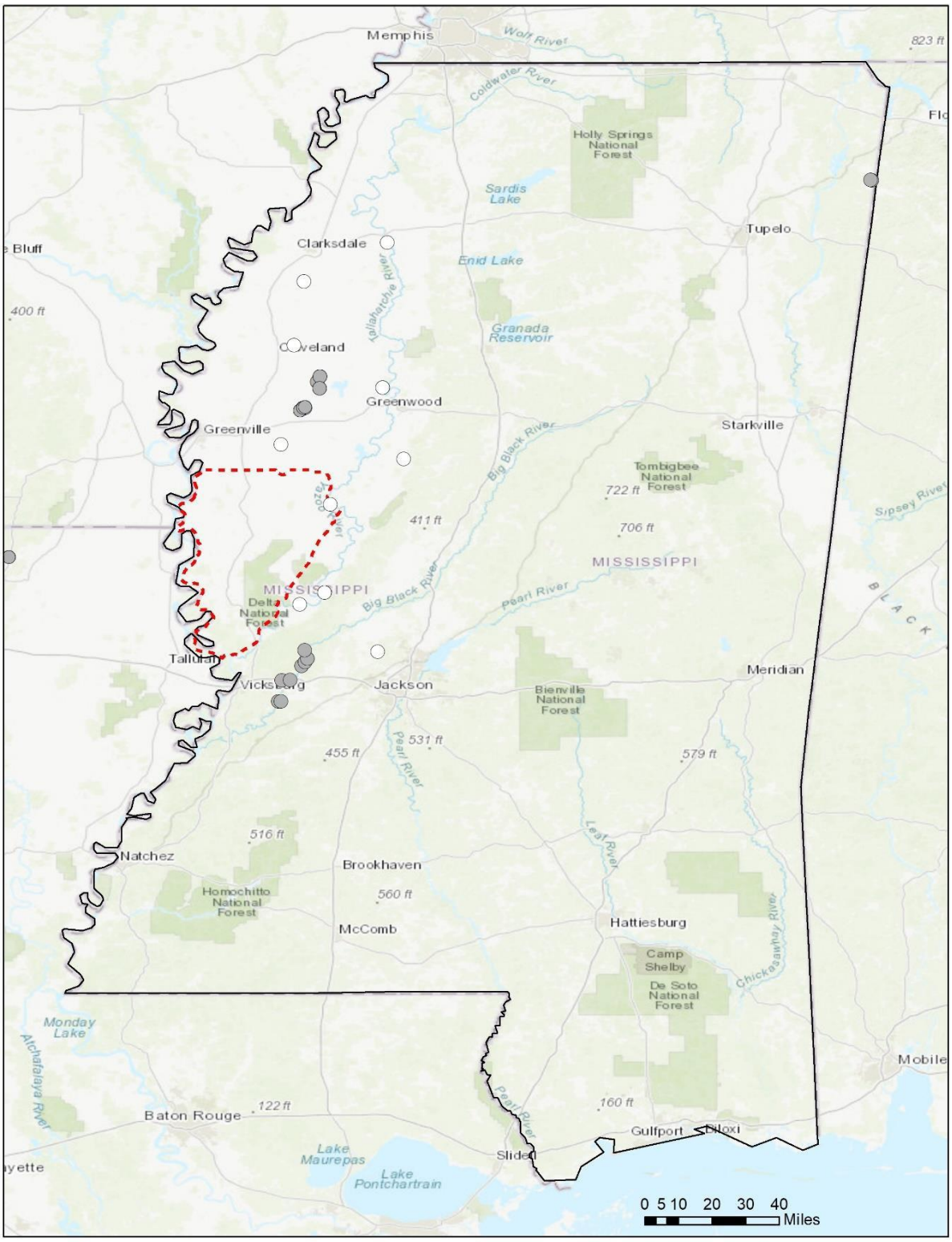

Figure 6. Distribution of the Rabbitsfoot in Mississippi. Grey dots represent recent survey efforts or MMNS records. White dots represent archaeological material.

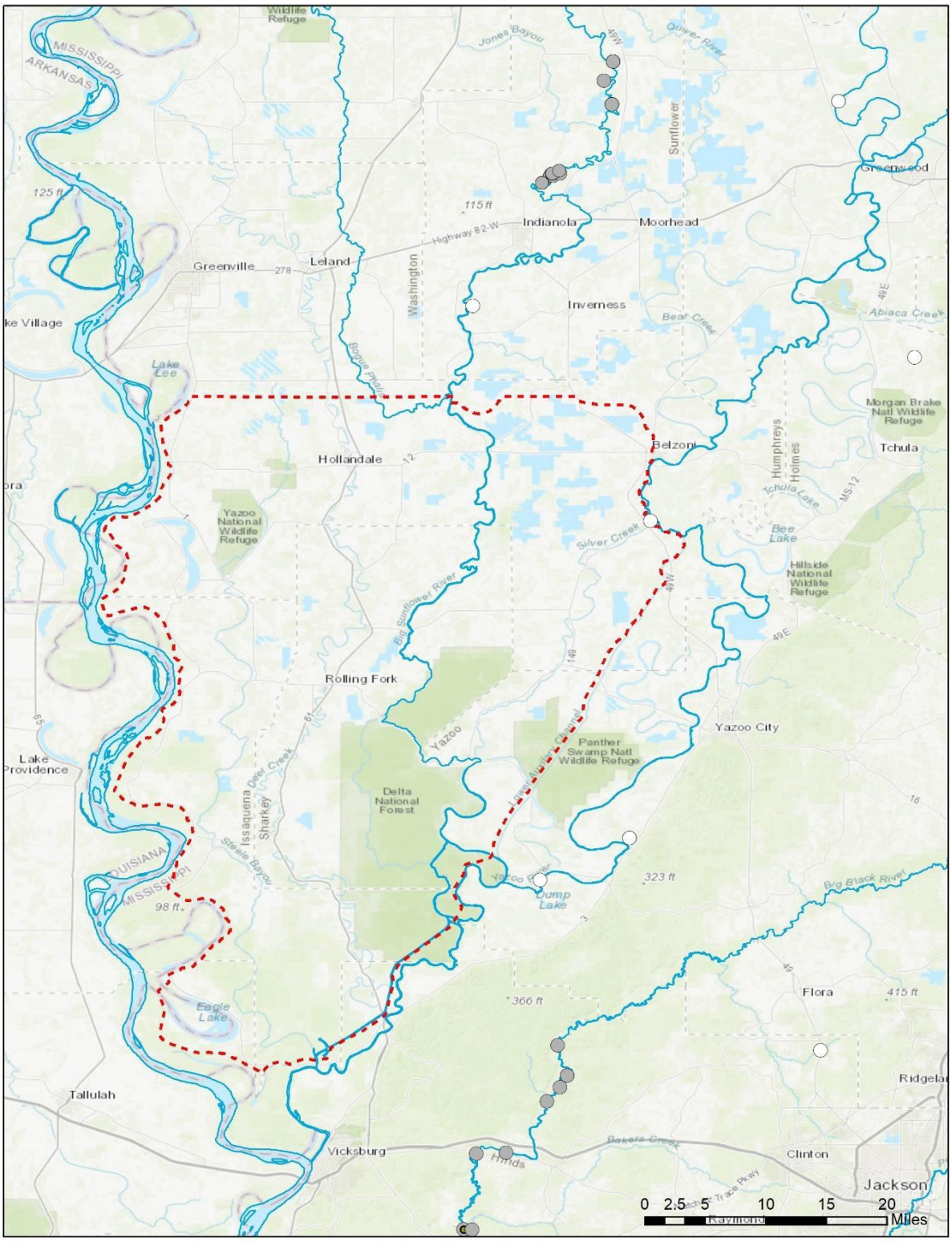

Figure 7. Occurrence of the Rabbitsfoot within the Yazoo Study Area (red outline). Grey dots represent recent survey efforts or MMNS records. White dots represent archaeological material.

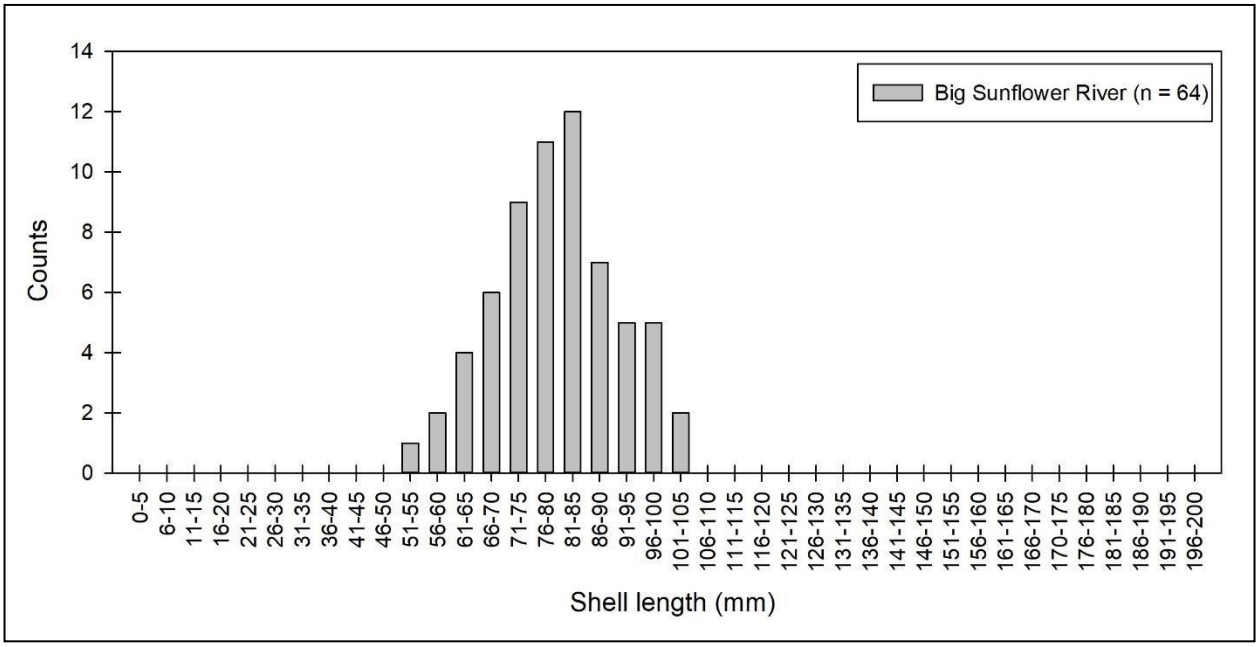

Figure 8. Length frequency histogram for individuals processed (live, fresh dead and weathered) from the Big Sunflower River 2014-2017.

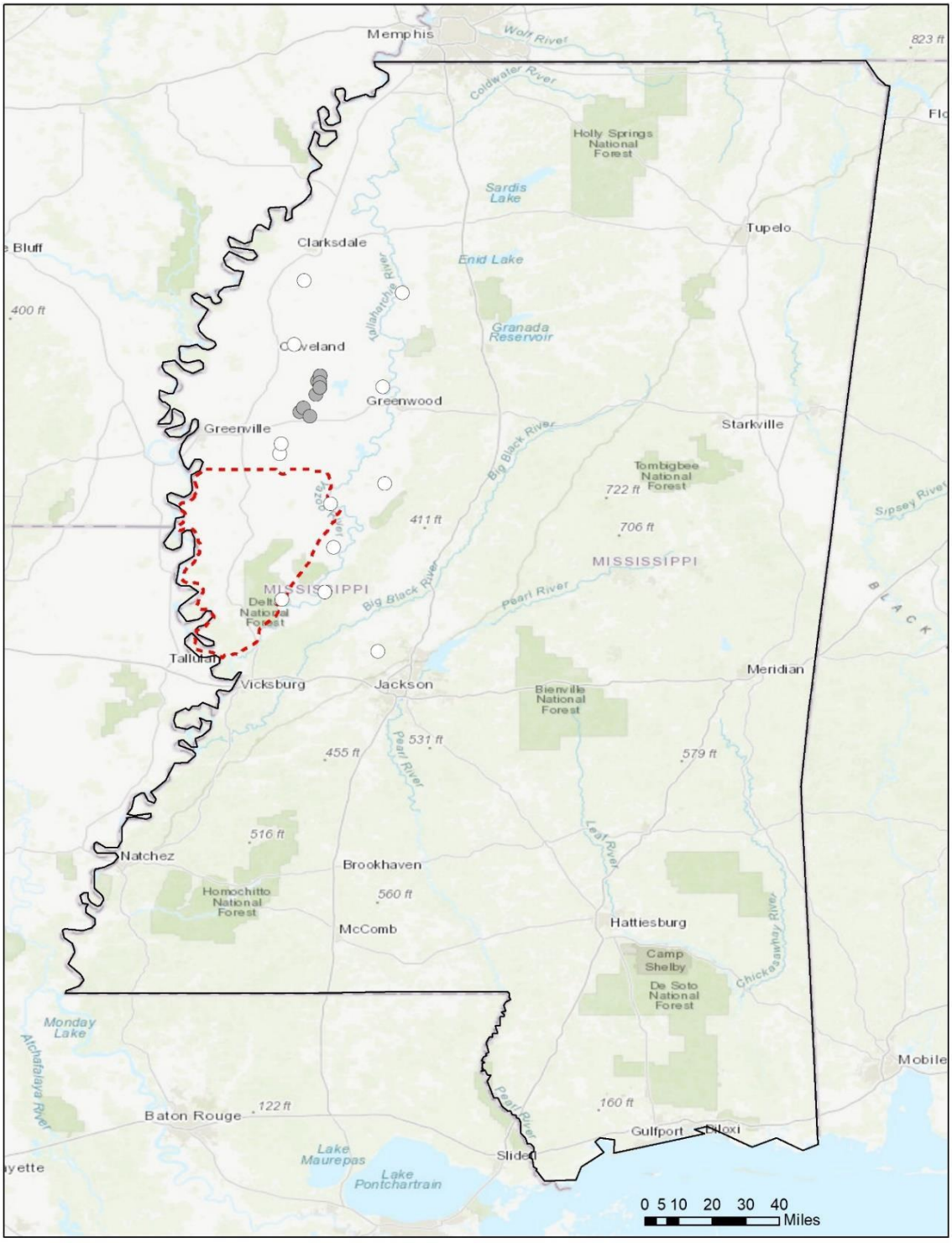

Figure 9. Distribution of the Sheepnose in Mississippi. Grey dots represent recent survey efforts or MMNS records. White dots represent archaeological material.

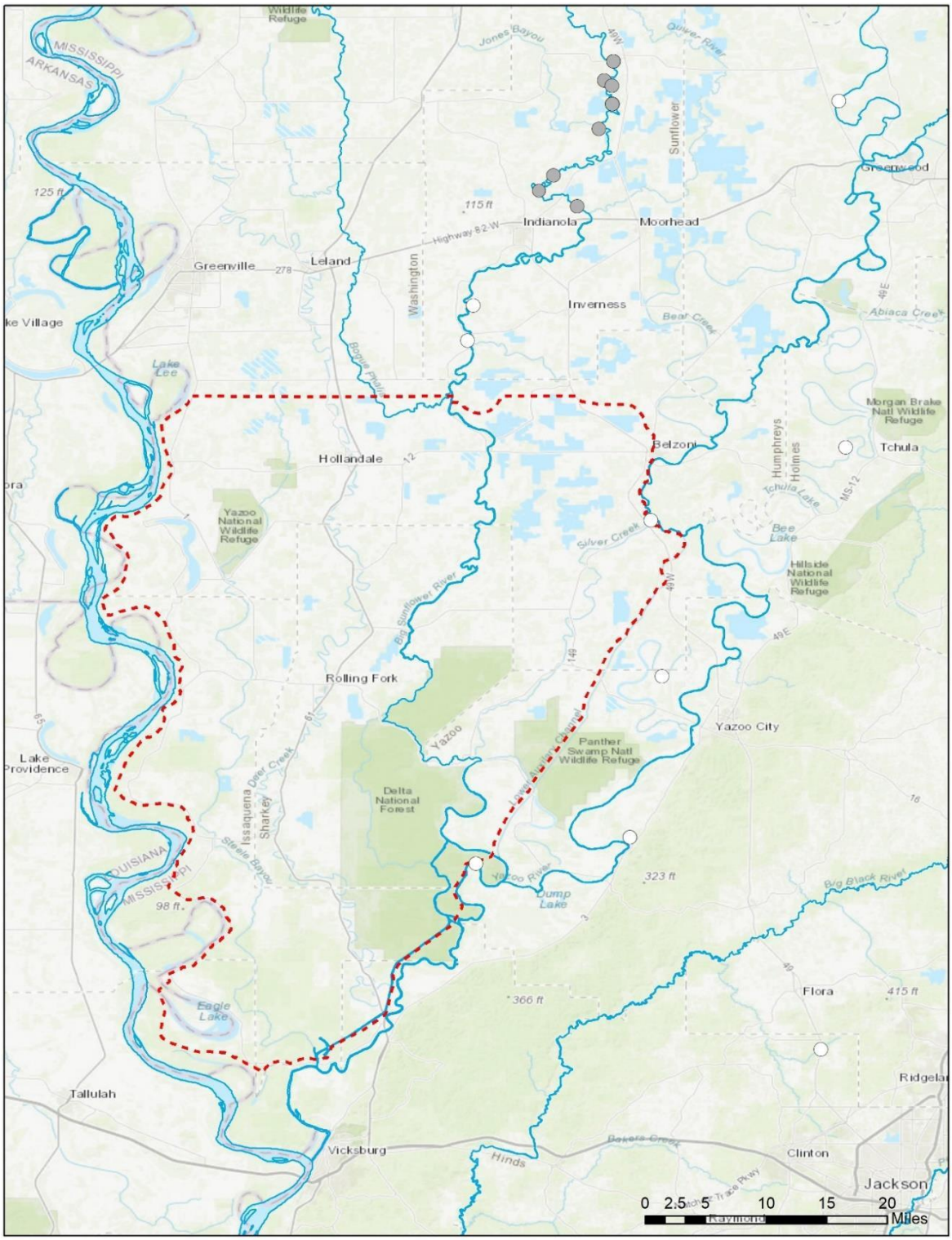

Figure 10. Occurrence of the Sheepnose within the Yazoo Study Area (red outline). Grey dots represent recent survey efforts or MMNS records. White dots represent archaeological material.

Table 1. Listing of freshwater mussel species occurring within the Yazoo basin following Jones et al. (2019). Taxonomy follows Williams et al. (2017). Mississippi status is based on Mississippi Natural Heritage Program ranks and are as follows: S1 = critically impaired, S2 = imperiled, S3 = rare or uncommon, S4 = widespread, abundant and apparently secure within the state, S5 = demonstrably secure within the state, SH = of historical occurrence within the state, SU = unranked. A state status with an asterisk indicates the species is listed by the State of Mississippi as endangered. National status categories are from Williams et al. (1993), and are E = endangered, T = threatened, SC = special concern and CS = currently stable. A national status with an asterisk indicates the species is listed by the USFWS as either threatened or endangered. Species highlighted in yellow are federally listed species reported from within the Yazoo Backwater Study Area. An "A" in the body of the table indicates that only archaeological remains of a particular species have been found in that drainage; a "B" denotes identification is questionable as the species has not been previously reported for the drainage. Data sources are 1 = Miller and Payne (1995), 2 = Miller et al. (1992) and 3 = Miller and Payne (2004). Acronyms within the table are QL = qualitative sample (e.g., timed searches along the shoreline), QT = quantitative sample (e.g., 0.25 m2 sampling quadrat), HBC = Holly Bluff Cutoff, and L&D 1 = Lock and Dam No. 1 on the Big Sunflower River.

Table 1. See title above.

				Data source	1	1	1	1	1
				Location	L&D 1	L&D 1	L&D 1	HBC	HBC
				Comments	downriver	downriver	upriver	downriver	upriver
Scientific Name	**Common Name**	**MS Status**	**National Status**	**Sample type**	QUAL	QUANT	QUAL	QUAL	QUAL
Actinonaias ligamentina	Mucket	S1*	CS						
Amblema plicata	Threeridge	S5	CS		X	X	X	X	X
Arcidens confragosus	Rock Pocketbook	S3	CS		X		X	X	X
Cyclonaias nodulata	Wartyback	S3	CS		X	X	X	X	X
Cyclonaias pustulosa	Pimpleback	S5	CS		X	X	X		
Cyprogenia aberti [A]	Western Fanshell	SX	T						
Ellipsaria lineolata	Butterfly	S2	SC			X			
Elliptio crassidens [B]	Elephantear	S4	CS						
Eurynia dilatata	Spike	S1*	CS						
Fusconaia flava	Wabash Pigtoe	S5	CS		X	X	X	X	X
Glebula rotundata	Round Pearlshell	S4	CS				X		
Lampsilis cardium	Plain Pocketbook	S3	SC						
Lampsilis hydiana	Louisiana Fatmucket	S2	CS				X		
Lampsilis siliquoidea	Fatmucket	S3	CS						
Lampsilis teres	Yellow Sandshell	S5	CS		X		X		X
Leptodea fragilis	Fragile Papershell	S5	CS		X	X	X	X	X
Ligumia recta	Black Sandshell	S1	SC						
Ligumia subrostrata	Pondmussel	S5	CS						
Megalonaias nervosa	Washboard	S4S5	CS		X	X	X	X	X
Obliquaria reflexa	Threehorn Wartyback	S5	CS		X	X	X	X	X
Obovaria subrotunda	Round Hickorynut	S2	SC						
Plectomerus dombeyanus	Bankclimber	S5	CS		X	X	X	X	X
Plethobasus cyphyus	Sheepnose	S1*	T*						
Pleurobema rubrum	Pyramid Pigtoe	S2*	T		X			X	X
Potamilus capax	Fat Pocketbook	S1*	E*						
Potamilus ohiensis	Pink Papershell	S3	CS				X		
Potamilus purpuratus	Bleufer	S5	CS		X	X	X	X	X
Pyganodon grandis	Giant Floater	S5	CS		X		X	X	X

Table 1. Continued.

Quadrula apiculata	Southern Mapleleaf	S5	CS						
Quadrula quadrula	Mapleleaf	S5	CS		X	X	X	X	X
Reginaia ebenus	Ebonyshell	S4	CS		X			X	
Strophitus radiatus	Rayed Creekshell	S2	SC						
Strophitus undulatus	Creeper	S1	CS						
Theliderma cylindrica	Rabbitsfoot	S1*	T*						
Theliderma metanevra [A]	Monkeyface	SX*	CS						
Toxolasma parvum	Lilliput	S4	CS						
Toxolasma texasiense	Texas Lilliput	S4	CS				X		
Tritogonia verrucosa	Pistolgrip	S4	CS		X			X	X
Truncilla donaciformis	Fawnsfoot	S4	CS				X		
Truncilla truncata	Deertoe	S3	CS			X	X		
Uniomerus declivis	Tapered Pondhorn	S3	CS				X		
Uniomerus tetralasmus	Pondhorn	S5	CS				X		
Utterbackia imbecillis	Paper Pondshell	S5	CS		X		X		
Utterbackiana suborbiculata	Flat Floater	S3S4	CS						
Villosa lienosa	Little Spectaclecase	S5	CS						
Villosa vibex	Southern Rainbow	S4	CS						
Corbicula fluminea	Asian Clam				X		X		

Table 1. Continued.

	1	1	1	1	1	1	1	1
	Gravel bar	L&D 1	HBC	HBC	Gravel bar	L&D 1	L&D 1	L&D 1
		downriver	downriver	upriver		downriver	upriver, RM 62.3	upriver of RM 62.3
Scientific Name	QUAL	QUAL	QUANT	QUANT	QUANT	QUANT	QUAL	QUAL
Actinonaias ligamentina								
Amblema plicata	X	X	X	X	X	X	X	X
Arcidens confragosus							X	X
Cyclonaias nodulata	X	X	X	X	X	X	X	X
Cyclonaias pustulosa			X		X	X	X	X
Cyprogenia aberti [A]								
Ellipsaria lineolata					X			
Elliptio crassidens [B]								
Eurynia dilatata								
Fusconaia flava	X		X	X	X	X	X	
Glebula rotundata							X	X
Lampsilis cardium								
Lampsilis hydiana							X	
Lampsilis siliquoidea								
Lampsilis teres	X						X	
Leptodea fragilis	X	X		X	X		X	X
Ligumia recta								X
Ligumia subrostrata								
Megalonaias nervosa	X		X	X	X	X	X	X
Obliquaria reflexa	X		X	X	X	X	X	X
Obovaria subrotunda								
Plectomerus dombeyanus	X	X	X	X	X	X	X	X
Plethobasus cyphyus								
Pleurobema rubrum		X			X	X		
Potamilus capax								
Potamilus ohiensis							X	
Potamilus purpuratus	X	X	X	X		X	X	X
Pyganodon grandis							X	X

Table 1. Continued.

Quadrula apiculata								
Quadrula quadrula	X		X	X	X		X	X
Reginaia ebenus						X		
Strophitus radiatus								
Strophitus undulatus								
Theliderma cylindrica	Rabbitsfoot	S1*	T*					
Theliderma metanevra [A]								
Toxolasma parvum								
Toxolasma texasiense								
Tritogonia verrucosa								
Truncilla donaciformis								
Truncilla truncata						X		X
Uniomerus declivis								
Uniomerus tetralasmus								
Utterbackia imbecillis		X						
Utterbackiana suborbiculata								
Villosa lienosa								
Villosa vibex								
Corbicula fluminea							X	

Table 1. Continued.

	1	1	1	1	1	1	1	1	1
	RM 66	RM 73.8	RM 62.2	RM 62.9	RM 65	RM 65.5a	RM 65.5b	RM 66	RM 67.4
	upriver L&D 1	upriver L&D 1							
Scientific Name	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL
Actinonaias ligamentina									
Amblema plicata	X	X	X	X	X	X	X	X	X
Arcidens confragosus		X		X					
Cyclonaias nodulata	X	X			X				
Cyclonaias pustulosa	X	X			X	X	X		
Cyprogenia aberti [A]									
Ellipsaria lineolata									
Elliptio crassidens [B]									
Eurynia dilatata									
Fusconaia flava	X	X						X	
Glebula rotundata	X	X		X	X			X	X
Lampsilis cardium									
Lampsilis hydiana									
Lampsilis siliquoidea									
Lampsilis teres	X	X	X	X	X	X	X	X	X
Leptodea fragilis	X	X	X				X		X
Ligumia recta									
Ligumia subrostrata									
Megalonaias nervosa	X	X					X	X	
Obliquaria reflexa	X	X			X				
Obovaria subrotunda									
Plectomerus dombeyanus	X	X	X	X	X	X	X	X	X
Plethobasus cyphyus									
Pleurobema rubrum									
Potamilus capax									
Potamilus ohiensis	X	X							
Potamilus purpuratus	X	X			X				X
Pyganodon grandis	X	X	X	X	X	X	X		X

Table 1. Continued.

Quadrula apiculata									
Quadrula quadrula	X	X	X					X	
Reginaia ebenus									
Strophitus radiatus									
Strophitus undulatus									
Theliderma cylindrica									
Theliderma metanevra [A]									
Toxolasma parvum									
Toxolasma texasiense									
Tritogonia verrucosa									
Truncilla donaciformis	X								
Truncilla truncata	X								
Uniomerus declivis									
Uniomerus tetralasmus									
Utterbackia imbecillis									
Utterbackiana suborbiculata									
Villosa lienosa									
Villosa vibex									
Corbicula fluminea									

Table 1. Continued.

	1	1	1	1	1	1	1	1	1	1	1
	RM 70.4	RM 71	RM 72	RM 72.9	RM 73	RM 73.5	RM 73.8	RM 74	RM 74.5	RM 75.2	RM 76
Scientific Name	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL
Actinonaias ligamentina											
Amblema plicata	X	X	X		X	X	X	X	X	X	X
Arcidens confragosus						X	X				
Cyclonaias nodulata							X				X
Cyclonaias pustulosa		X				X	X	X			
Cyprogenia aberti [A]											
Ellipsaria lineolata											
Elliptio crassidens [B]											
Eurynia dilatata											
Fusconaia flava											
Glebula rotundata	X	X	X	X	X	X	X	X		X	X
Lampsilis cardium											
Lampsilis hydiana											
Lampsilis siliquoidea											
Lampsilis teres	X	X	X	X	X	X	X	X	X	X	X
Leptodea fragilis		X	X	X							
Ligumia recta											
Ligumia subrostrata											
Megalonaias nervosa	X	X				X		X		X	X
Obliquaria reflexa											
Obovaria subrotunda											
Plectomerus dombeyanus	X	X	X		X	X	X	X	X	X	X
Plethobasus cyphyus											
Pleurobema rubrum											
Potamilus capax											
Potamilus ohiensis										X	
Potamilus purpuratus				X	X		X	X	X	X	X
Pyganodon grandis	X	X	X			X	X	X		X	X

Table 1. Continued.

Quadrula apiculata											
Quadrula quadrula								X			
Reginaia ebenus											
Strophitus radiatus											
Strophitus undulatus											
Theliderma cylindrica											
Theliderma metanevra [A]											
Toxolasma parvum											
Toxolasma texasiense		X					X				
Tritogonia verrucosa											
Truncilla donaciformis											
Truncilla truncata											
Uniomerus declivis											
Uniomerus tetralasmus			X								
Utterbackia imbecillis			X								
Utterbackiana suborbiculata											
Villosa lienosa											
Villosa vibex											
Corbicula fluminea							X				

Table 1. Continued.

	1	1	1	1	1	1	1	1	1	1	1
	RM 77.3	RM 78	RM 78.1	RM 80	RM 82.7	RM 83	RM 85.2	RM 94.7	RM 95.2	RM 96.9	RM 98
Scientific Name	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL
Actinonaias ligamentina											
Amblema plicata	X		X		X	X	X	X	X	X	
Arcidens confragosus			X				X	X			
Cyclonaias nodulata							X				
Cyclonaias pustulosa			X				X	X			
Cyprogenia aberti [A]											
Ellipsaria lineolata											
Elliptio crassidens [B]											
Eurynia dilatata											
Fusconaia flava							X				
Glebula rotundata	X					X		X	X		
Lampsilis cardium											
Lampsilis hydiana											
Lampsilis siliquoidea											
Lampsilis teres	X		X	X	X	X	X		X		X
Leptodea fragilis		X					X			X	
Ligumia recta											
Ligumia subrostrata											
Megalonaias nervosa	X			X	X	X	X		X		
Obliquaria reflexa						X	X				
Obovaria subrotunda											
Plectomerus dombeyanus	X		X	X	X	X	X	X	X	X	X
Plethobasus cyphyus											
Pleurobema rubrum											
Potamilus capax											
Potamilus ohiensis				X	X						
Potamilus purpuratus	X	X	X	X	X	X	X	X		X	
Pyganodon grandis	X		X	X	X	X	X		X		

Table 1. Continued.

Quadrula apiculata											
Quadrula quadrula									X		
Reginaia ebenus											
Strophitus radiatus											
Strophitus undulatus											
Theliderma cylindrica											
Theliderma metanevra [A]											
Toxolasma parvum											
Toxolasma texasiense					X	X					
Tritogonia verrucosa											
Truncilla donaciformis											
Truncilla truncata											
Uniomerus declivis								X			
Uniomerus tetralasmus											
Utterbackia imbecillis											
Utterbackiana suborbiculata											
Villosa lienosa											
Villosa vibex											
Corbicula fluminea											

Table 1. Continued.

	1	1	1	1	1	1	1	1	1	1
	RM 98.8	RM 101.5	RM 109.9	RM 114.8	RM 117	RM 123.5	RM 128.5	RM 131.5	RM 134	RM 139
Scientific Name	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL
Actinonaias ligamentina										
Amblema plicata			X		X	X	X	X	X	X
Arcidens confragosus			X					X		X
Cyclonaias nodulata										X
Cyclonaias pustulosa	X	X	X				X	X	X	X
Cyprogenia aberti [A]										
Ellipsaria lineolata										
Elliptio crassidens [B]										
Eurynia dilatata										
Fusconaia flava			X				X	X	X	
Glebula rotundata										
Lampsilis cardium										
Lampsilis hydiana						X				
Lampsilis siliquoidea										
Lampsilis teres	X					X			X	X
Leptodea fragilis	X							X		
Ligumia recta										
Ligumia subrostrata										
Megalonaias nervosa		X	X			X	X	X		
Obliquaria reflexa			X					X		
Obovaria subrotunda										
Plectomerus dombeyanus	X	X	X			X	X	X	X	
Plethobasus cyphyus										
Pleurobema rubrum								X		
Potamilus capax										
Potamilus ohiensis		X								X
Potamilus purpuratus	X				X			X	X	
Pyganodon grandis		X	X					X		X

Table 1. Continued.

Quadrula apiculata										
Quadrula quadrula							X	X		X
Reginaia ebenus										
Strophitus radiatus										
Strophitus undulatus										
Theliderma cylindrica										
Theliderma metanevra [A]										
Toxolasma parvum										
Toxolasma texasiense	X							X		
Tritogonia verrucosa										
Truncilla donaciformis										
Truncilla truncata										
Uniomerus declivis										
Uniomerus tetralasmus										
Utterbackia imbecillis										
Utterbackiana suborbiculata										
Villosa lienosa										
Villosa vibex										
Corbicula fluminea										

Table 1. Continued.

	1	1	1	1	1	1	2	2	2
	RM 140.3	RM 141.5	RM 144.6	RM 147	RM 148.2	RM 149.2	RM 35.2	RM 35.2	RM 35.2
							shallow water	deep water	
Scientific Name	QUAL	QUAL	QUAL	QUAL	QUAL	QUAL	QUANT	QUANT	QUAL
Actinonaias ligamentina									X
Amblema plicata		X		X		X	X	X	
Arcidens confragosus						X			X
Cyclonaias nodulata		X				X	X	X	
Cyclonaias pustulosa		X			X	X	X	X	
Cyprogenia aberti [A]									
Ellipsaria lineolata									
Elliptio crassidens [B]									X
Eurynia dilatata									
Fusconaia flava				X	X		X	X	
Glebula rotundata									X
Lampsilis cardium									
Lampsilis hydiana				X					
Lampsilis siliquoidea									
Lampsilis teres						X			X
Leptodea fragilis							X	X	
Ligumia recta									
Ligumia subrostrata									
Megalonaias nervosa					X	X	X	X	
Obliquaria reflexa						X	X	X	
Obovaria subrotunda									
Plectomerus dombeyanus		X	X	X		X	X	X	
Plethobasus cyphyus									
Pleurobema rubrum							X		
Potamilus capax									
Potamilus ohiensis									X
Potamilus purpuratus		X	X		X	X			X
Pyganodon grandis									X

Table 1. Continued.

Quadrula apiculata									
Quadrula quadrula		X					X	X	
Reginaia ebenus									
Strophitus radiatus									
Strophitus undulatus									
Theliderma cylindrica									
Theliderma metanevra [A]									
Toxolasma parvum									
Toxolasma texasiense					X				X
Tritogonia verrucosa									
Truncilla donaciformis							X		
Truncilla truncata							X		
Uniomerus declivis								X	
Uniomerus tetralasmus									
Utterbackia imbecillis									
Utterbackiana suborbiculata									
Villosa lienosa									
Villosa vibex									
Corbicula fluminea						X	X	X	

Table 1. Continued.

	3	3	COUNT
	RM 6.9-85	RM 85-150	65
	2003, channel	2000, shoal	
Scientific Name	QUAL	QUANT	
Actinonaias ligamentina			1
Amblema plicata	X	X	54
Arcidens confragosus	X		19
Cyclonaias nodulata	X	X	26
Cyclonaias pustulosa	X	X	34
Cyprogenia aberti [A]			0
Ellipsaria lineolata		X	3
Elliptio crassidens [B]			1
Eurynia dilatata			0
Fusconaia flava	X	X	25
Glebula rotundata	X		25
Lampsilis cardium			0
Lampsilis hydiana			4
Lampsilis siliquoidea			0
Lampsilis teres		X	40
Leptodea fragilis	X	X	28
Ligumia recta			1
Ligumia subrostrata			0
Megalonaias nervosa	X	X	39
Obliquaria reflexa	X	X	24
Obovaria subrotunda			0
Plectomerus dombeyanus	X	X	57
Plethobasus cyphyus		X	1
Pleurobema rubrum		X	9
Potamilus capax			0
Potamilus ohiensis	X		11
Potamilus purpuratus	X	X	43
Pyganodon grandis	X		35

Table 1. Continued.

Quadrula apiculata			0
Quadrula quadrula	X	X	25
Reginaia ebenus		X	4
Strophitus radiatus			0
Strophitus undulatus			0
Theliderma cylindrica			0
Theliderma metanevra [A]			0
Toxolasma parvum			0
Toxolasma texasiense			9
Tritogonia verrucosa		X	4
Truncilla donaciformis		X	4
Truncilla truncata		X	7
Uniomerus declivis			3
Uniomerus tetralasmus			2
Utterbackia imbecillis			4
Utterbackiana suborbiculata	X		1
Villosa lienosa			0
Villosa vibex			0
			0
Corbicula fluminea			7

Table 2. List of mussels collected at 20 stations within the Yazoo Study Area using a mussel sled during July 2020. Valve condition follows the terminology of Haag and Warren (1998). Conservation status of each mussel species is listed in Table 1.

Scientific name	Common name	Live	Fresh Dead	Weathered	Relict
Amblema plicata	Threeridge		2	4	13
Cyclonaias nodulata	Wartyback	5	1	3	2
Cyclonaias pustulosa	Pimpleback				1
Lampsilis teres	Yellow Sandshell		52	1	2
Megalonaias nervosa	Washboard			2	5
Obliquaria reflexa	Threehorn Wartyback			3	1
Obovaria sp.	unidentified hickorynut				1
Plectomerus dombeyanus	Bankclimber		3	7	3
Pleurobema rubrum	Pyramid Pigtoe				2
Potamilus purpuratus	Bleufer		1		2
Pyganodon grandis	Giant Floater		7	15	2
Quadrula quadrula	Mapleleaf			2	7
Toxolasma texasiense	Texas Lilliput		20	1	
Truncilla donaciformis	Fawnsfoot				1
Unionidae	unionid fragments			2	14
Utterbackia imbecillis	Paper Pondshell		2		
Utterbackiana suborbiculata	Flat Floater			2	
Corbicula fluminea	Asian Clam			1	12
Gastropodae	unidentified snail				1
Planorbidae	unidentified snail		1		
Campeloma sp.	unidentified snail				1
Viviparus subpurpureus	Olive Mysterysnail		1	2	12

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6.0 LIST OF PREPARERS, CONTACTS MADE, AND REVIEW

Name	Organization	Section
Preparers:		
Sara Thames	USACE, MVK	1.0, 2.0, 3.0
Bruce Pruitt	USACE, ERDC	1.0, 2.0, 3.0, 4.0, Overall Organization
Richard Fischer	USACE, ERDC	Terrestrial TES
Michael Guilfoyle	USACE, ERDC	Terrestrial TES
Jacob Jung	USACE, ERDC	Terrestrial TES
Todd Slack	USACE, ERDC	Aquatic TES
Jack Killgore	USACE, ERDC	Aquatic TES
Contacts:		
David Felder	USFWS, MES	Approved BA Outline, 16July2020
Peer Input:		
Rachel Nifong	USACE, MVK	Entire Document
Tammy Gilmore	USACE, MVN	Entire Document

Northern Long-Eared Bat 4(d) Rule Streamlined Consultation Form

Federal agencies should use this form for the optional streamlined consultation framework for the northern long-eared bat (NLEB). This framework allows federal agencies to rely upon the U.S. Fish and Wildlife Service's (USFWS) January 5, 2016, intra-Service Programmatic Biological Opinion (BO) on the final 4(d) rule for the NLEB for section 7(a)(2) compliance by: (1) notifying the USFWS that an action agency will use the streamlined framework; (2) describing the project with sufficient detail to support the required determination; and (3) enabling the USFWS to track effects and determine if reinitiation of consultation is required per 50 CFR 402.16.

This form is not necessary if an agency determines that a proposed action will have no effect to the NLEB or if the USFWS has concurred in writing with an agency's determination that a proposed action may affect, but is not likely to adversely affect the NLEB (i.e., the standard informal consultation process). Actions that may cause prohibited incidental take require separate formal consultation. Providing this information does not address section 7(a)(2) compliance for any other listed species.

Information to Determine 4(d) Rule Compliance:	**YES**	**NO**
1. Does the project occur wholly outside of the WNS Zone[1]?	☐	☒
2. Have you contacted the appropriate agency[2] to determine if your project is near known hibernacula or maternity roost trees?	☒	☐
3. Could the project disturb hibernating NLEBs in a known hibernaculum?	☐	☒
4. Could the project alter the entrance or interior environment of a known hibernaculum?	☐	☒
5. Does the project remove any trees within 0.25 miles of a known hibernaculum at any time of year?	☐	☒
6. Would the project cut or destroy known occupied maternity roost trees, or any other trees within a 150-foot radius from the maternity roost tree from June 1 through July 31.	☐	☒

You are eligible to use this form if you have answered yes to question #1 **or** yes to question #2 **and** no to questions 3, 4, 5 and 6. The remainder of the form will be used by the USFWS to track our assumptions in the BO.

Agency and Applicant[3] (Name, Email, Phone No.):

USACE: A. Sara Thames; sara.thames@usace.army.mil; 601.631.5894

Project Name: Draft Supplemental No. 2 to the 2007 Final Supplemental No. 1 to the 1982 Yazoo Area Pump Project

Project Location (include coordinates if known): pump station (32.54016/-90.79869) and borrow area (32.46176/-90.89743)

[1] http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf
[2] See http://www.fws.gov/midwest/endangered/mammals/nleb/nhisites.html
[3] If applicable - only needed for federal actions with applicants (e.g., for a permit, etc.) who are party to the consultation.

MISSISSIPPI

Basic Project Description (provide narrative below or attach additional information):

See attached memo

General Project Information	YES	NO
Does the project occur within 0.25 miles of a known hibernaculum?	☐	☒
Does the project occur within 150 feet of a known maternity roost tree?	☐	☒
Does the project include forest conversion[4]? (if yes, report acreage below)	☒	☐
Estimated total acres of forest conversion	300ac	
If known, estimated acres[5] of forest conversion from April 1 to October 31		
If known, estimated acres of forest conversion from June 1 to July 31[6]		
Does the project include timber harvest? (if yes, report acreage below)	☐	☒
Estimated total acres of timber harvest		
If known, estimated acres of timber harvest from April 1 to October 31		
If known, estimated acres of timber harvest from June 1 to July 31		
Does the project include prescribed fire? (if yes, report acreage below)	☐	☒
Estimated total acres of prescribed fire		
If known, estimated acres of prescribed fire from April 1 to October 31		
If known, estimated acres of prescribed fire from June 1 to July 31		
Does the project install new wind turbines? (if yes, report capacity in MW below)	☐	☒
Estimated wind capacity (MW)		

Agency Determination:

By signing this form, the action agency determines that this project may affect the NLEB, but that any resulting incidental take of the NLEB is not prohibited by the final 4(d) rule.

If the USFWS does not respond within 30 days from submittal of this form, the action agency may presume that its determination is informed by the best available information and that its project responsibilities under 7(a)(2) with respect to the NLEB are fulfilled through the USFWS January 5, 2016, Programmatic BO. The action agency will update this determination annually for multi-year activities.

The action agency understands that the USFWS presumes that all activities are implemented as described herein. The action agency will promptly report any departures from the described activities to the appropriate USFWS Field Office. The action agency will provide the appropriate USFWS Field Office with the results of any surveys conducted for the NLEB. Involved parties will promptly notify the appropriate USFWS Field Office upon finding a dead, injured, or sick NLEB.

Signature: A. Sara Thames Date Submitted: 30 Sept 2024

[4] Any activity that temporarily or permanently removes suitable forested habitat, including, but not limited to, tree removal from development, energy production and transmission, mining, agriculture, etc. (see page 48 of the BO).
[5] If the project removes less than 10 trees and the acreage is unknown, report the acreage as less than 0.1 acre.
[6] If the activity includes tree clearing in June and July, also include those acreage in April to October.

MIGRATORY BIRDS APPENDIX

1.0 INTRODUCTION

The Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. §§703-712) as amended, prohibits the direct and intentional take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior, U.S. Fish and Wildlife Service (USFWS). Historically, this prohibition had been interpreted by the U.S. Department of the Interior (DOI) to apply to both deliberate acts intended to take or kill migratory birds as well as the incidental taking or killing of such birds. That interpretation was overturned in 2017 when the DOI Office of the Solicitor issued Solicitor's Opinion M-37050 that interpreted the statute as not prohibiting incidental take but instead only applying to "direct and affirmative purposeful actions that reduce migratory birds, their eggs, or their nests, by killing or capturing, to human control." A pending Regulation that would codify this new Solicitor's Opinion currently is being reviewed within the Office of Management and Budget. Because of uncertainty regarding the interpretation of how the MBTA applies to incidental take and in light of the other authorities and policies that encourage or require the conservation of migratory birds, the USACE Director of Civil Works issued a policy memorandum on 28 March 2018 (USACE 2018), directing the agency to continue to work to minimize the incidental take of migratory birds to the extent practicable, and to coordinate as appropriate with the USFWS, until further clarification is provided.

A migratory bird species is included on the list of MBTA-protected species if it meets one or more of the following criteria (50 CFR §10.13):

1. It occurs in the United States or U.S. territories as the result of natural biological or ecological processes and is currently, or was previously listed as, a species or part of a family protected by one of the four international treaties or their amendments.
2. Revised taxonomy results in it being newly split from a species that was previously on the list, and the new species occurs in the United States or U.S. territories as the result of natural biological or ecological processes.
3. New evidence exists for its natural occurrence in the United States or U.S. territories resulting from natural distributional changes and the species occurs in a protected family.

The list of migratory bird species protected by the MBTA is primarily based on bird families and species included in the four international treaties with Canada, Russia, Japan, and Mexico. The list of bird species is contained in 50 C.F.R. §10.13. (referred to frequently as the 10.13 list) which was last updated as a Final Rule in 2020 (Federal Register Vol. 85, No. 74) and incorporates the most current scientific information on taxonomy and natural distribution. USFWS regulations include most native birds found in the U.S. as species protected by the MBTA, including species that do not migrate internationally, and even species that do not migrate at all. See 50 C.F.R. for the complete list of bird species protected under the MBTA.

In addition to the 10.13 list, the USFWS maintains a list of "Birds of Conservation Concern." The 1988 amendment to the Fish and Wildlife Conservation Act mandates that the USFWS identify species, subspecies, and populations of all migratory nongame birds that without additional conservation action are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973, as amended. The USFWS *Birds of Conservation Concern 2008*

(BoCC*;* USFWS 2008) is the most recent effort to carry out this mandate[1]. The overall goal of the BoCC list is to identify those bird taxa (beyond those already designated as federally threatened or endangered) that represent the highest conservation priorities of the USFWS.

Considerable data on the distribution, abundance, and population trends of migratory birds are more widely available in recent years because of on-line programs (e.g., the Cornell University Laboratory of Ornithology eBird® platform; Cornell 2020) that allow users to report bird sightings anywhere in the world. eBird, which currently includes more than 1.5 billion bird records, contributes a wealth of information on the distribution and abundance of birds, making it the most robust avian database in existence.

Habitat loss, feral and free-ranging domestic dogs and cats, pesticides, climate change, light pollution, and a variety of other stressors are all known to contribute to declines for migratory birds (Terborgh 1989, Rosenberg et al. 2019). Habitat loss or alteration is believed to be the leading cause of many of these declines and, in particular, the loss of floodplain forests in the Mississippi Alluvial Valley (MAV) has contributed to population declines and even extinction of floodplain forest-dependent birds, including the Ivory-billed Woodpecker (*Campephilus principalis*) and Bachman's Warbler (*Vermivora bachmanii*) (Twedt et al. 1999). Water resources development in many parts of the world has resulted in serious reductions in the frequency, extent, and duration in which floodplain forest are inundated, leading to significant habitat change and loss of productivity (McGinness et al. 2018). McGinness et al. (2018) found that insufficient flooding was associated with degradation of floodplain forest condition and structure, as well as shifts in the relative abundance of key forest bird species. They suggest that changes in flooding frequency are associated with significant shifts in site character and ultimately transitions in community composition, even within the same broad vegetation type which in turn influences terrestrial fauna of floodplain ecosystems.

Restoration in the MAV has focused largely on forested wetlands to benefit breeding landbirds, recreational hunting and fishing, hydrologic restoration of wetland habitats to support migrating shorebirds and wintering waterfowl, and modification of the flood control infrastructure along the mainstem Mississippi River to benefit at-risk and threatened and endangered species. Since migratory birds that utilize forest and forested wetland habitat have experienced significant declines (Robinson et al. 2019), these birds are often the target beneficiaries of reforestation and bottomland hardwood restoration in the MAV (Twedt et al. 2007). In addition to forest restoration, issues of forest size, landscape context, presence of forest corridors, and overall landscape configuration are important in long-term considerations for forest bird conservation.

Although the acquisition of easement and mitigation lands are often influenced by land availability, price, willingness to sell, and current land-use, it is prudent to acquire lands strategically that maximize potential benefits for wildlife and that assist in the mitigation offset from habitat loss or alteration. Strategic planning should provide significant value to new easement and mitigation lands that are restored within the MAV.

[1] A draft update to the BoCC list has been completed by the USFWS, but as of the date of this report has not been officially released.

The Proposed Plan will implement a 14,000 cfs pump station that will be in operation when Steele Bayou water control structure is closed and landside water levels reach 87 feet National Geodetic Vertical Datum (NGVD 29). Pump operation will result in a reduction of flooded acres above 87 feet (NGVD 29) during some years, primarily within the southern portion of the Yazoo Basin. Previously, the construction and operation of the pump station has been estimated by some outside entities, and reported widely on internet sites and various fact sheets, to drain, destroy, or otherwise reduce wetland habitat for multiple water-dependent birds (e.g., Great Blue Herons, Great and Snowy Egrets, White Ibis) by up to 200,000 acres within the Yazoo Study Area acres (e.g., Mississippi Interstate Cooperative Resource Association 2008). The most likely impacts of the Proposed Plan within the Yazoo Study Area would be changes in hydrology within forested habitats which may result in potential alteration of forest structure and composition over time. Loss of mature floodplain forests could potentially have the most negative impacts on migratory birds that require varying levels of annual inundation upon the landscape to maintain habitat to meet life-history needs. Other habitats in the region important to non-forest migratory birds, including herbaceous, pasture, old field, scrub/shrub, and agricultural lands, might also be impacted due to decreases in intermittent flooding events. In this report, we assessed the potential, and primarily qualitative, direct and indirect impacts of construction and operation of the Proposed Plan on migratory birds that are known to utilize bottomland hardwood and other wetland habitats within the Yazoo Study Area.

2.0 OBJECTIVES

The objectives of this appendix are to 1) present information on species composition and habitat availability to migratory birds within the boundaries of the Yazoo Study Area, and discuss potential changes that could occur due to construction and operations of the Proposed Plan, 2) assess the potential direct impacts of excavation of borrow materials and the subsequent construction of the pump station, 3) assess projected changes in hydrology and subsequent indirect impacts of the Proposed Plan to habitats important to migratory birds within the Yazoo Study Area, and 4) discuss and evaluate the various alternatives of avoiding, minimizing, and compensating for unavoidable adverse impacts to migratory birds following the construction and operation associated with the Proposed Plan.

3.0 PROJECT AREA

The Yazoo Study Area encompasses an area of approximately 926,000 acres and extends from north of Vicksburg, Mississippi, to south of Clarksdale, Mississippi, and bordered to the west by the Mississippi River and to the east by Yazoo City and Greenwood, Mississippi. The Yazoo Study Area has been classified into seven flood event categories used to predict the cumulative extent of flooding during the 1, 2, 5, 10, 25, 50, and 100-year flood events for the No Action and Proposed Plan (Figure 1). Topographic relief within the Yazoo Study Area is relatively low as this area encompasses the floodplains of the Yazoo and Little Sunflower Rivers, and Steele Bayou. Stream gauge levels and total area inundated with respect to elevation (NGVD 29) are provided in Table 1.

In the Yazoo Basin, the majority of the landscape is dominated by agricultural fields with blocks of forest and forested wetlands in relatively small, isolated numbers. However, the southern portion of the Yazoo Basin (i.e., Yazoo Study Area) does contain larger blocks of forest including National Wildlife Refuges (NWR; e.g., Theodore Roosevelt and Yazoo NWRs), National Forests (i.e., Delta National Forest [DNF]) and Wildlife Management Areas (e.g., Mahannah Wildlife Management Area), all of which are very important habitat for a multitude of fish and wildlife species.

4.0 METHODS

Migratory birds occurring within the Yazoo Study Area boundaries were addressed from the list available from the research working group of Partners in Flight (PIF, Martin and Finch 1995), through the USFWS Information for Planning and Consultation (IPaC) portal (USFWS 2020), and the USFWS BoCC for the Study Area. For this assessment, recent biological and ecological data were obtained from published literature, communication with experts, and available online databases.

The IPaC was used to determine if any federally listed species under ESA, listed species critical habitat, or BoCC might occur within the Yazoo Study Area. A variety of resources were also used, including published and unpublished sources noting bird species found in the Yazoo Study Area, to determine if predicted changes in hydrology on the landscape could impact selected species, and to provide recommendations to avoid or minimize any impacts resulting from construction and operation of the pump station under the Proposed Plan.

We used the Cornell Laboratory of Ornithology's eBird® (Cornell 2020) to provide qualitative assessments about a species' possible presence or absence in the Yazoo Study Area. While eBird data can assist in gathering insights into distribution and relative abundance of birds, and those data undergo significant scientific vetting by regional qualified reviewers, dependence on observations associated with unequal efforts in coverage of remote areas, including the Yazoo Study Area, allows us to use these data only as an index of overall presence of species. This tool was not used to make definitive conclusions of presence/absence if a species was not reported in eBird within the Yazoo Study Area.

Opportunistic data was collected on the presence of avian species while collecting other habitat data associated with Habitat Evaluation Procedures (HEP) analyses (See Terrestrial Appendix). During the mid-July 2020 two-week field investigation in the Yazoo Study Area, all three authors well-versed in visual and aural detections of birds recorded all birds seen or heard at each of 53 HEP sampling points, as well as incidental detections of birds while walking or driving among sampling points.

A field assessment was conducted of potential conservation easement or fee-owned mitigation sites that would provide opportunities for (a) landscape connectivity from the Mississippi River, through the DNF, to Panther Swamp NWR; (b) creation of moist-soil management (MSM) units and other water features within agricultural fields having suitable topography; and (c) reduction

of forest habitat fragmentation through strategic acquisition of agricultural lands that could be replanted to bottomland hardwood forest. GIS and aerial imagery were used to identify habitat blocks within the Yazoo Study Area that could provide for these potential benefits. Criteria were considered such as least amount of distance required to connect larger forest blocks, interspersion of forest and agricultural areas, presence of streams for which riparian rehabilitation would provide connections, and presence of depressional areas that were still inundated during the July fieldwork. The areas were digitized in GIS and prioritized based on perceived ease of connecting habitat fragments with the smallest acreage to create movement corridors, existing wildlife use, and current hydrology (e.g., some lower elevation sites that were wet in July likely may not need water control structures to function)

The U.S. Army Corps of Engineers Vicksburg District (MVK) modeled hydrology within the Yazoo Study Area for the 23-day inundation (25% exceedance elevation) during a 90-day period each spring (March through May) over the 42-year Period-of-Record (POR) of the current draft supplement to the 2007 FSEIS (1978-2019). MVK also used the Flood Event Simulation Model (FESM) flood mapping tool to determine the extent of inundation across the Yazoo Study Area by the 23-day duration water elevation. These data were provided by MVK to U.S. Army Engineer Research and Development Center-Environmental Laboratory in summary form within Microsoft Excel.

5.0 RESULTS

The IPaC and BoCC analyses identified 29 species (and their primary habitats) that regularly use or occupy habitats within the Yazoo Study Area (Table 2). We provide details below on habitat requirements, distribution, population status, and known detections of each species within the Yazoo Study Area. The MVK hydrologic analysis that modeled the 23-day inundation during spring (March through May) over the POR suggests, with the Proposed Plan, a loss (albeit highly variable by year) of up to 34,000 acres of inundated habitat including 23,500 acres of inundated floodplain forest for water- and wetland-dependent birds (e.g., herons, egrets, ibises) that utilize this habitat for foraging or breeding (Figure 2).

For the 42-year POR of the current draft supplement to the 2007 FSEIS (1978-2019), maximum spring water elevations for Steele Bayou and Little Sunflower River have met or exceeded an elevation of 87 feet (NGVD 29) in 24 (57.1%) and 26 (61.9%) years, respectively, (D. Johnson, MVK, Pers. Comm.). Unless future hydrology within the Mississippi and Yazoo River watersheds changes significantly, on average, conditions under the No Action Alternative are expected to lead to at least periodic inundation in the Yazoo Study Area above 87 feet (NGVD 29) every second-year. These infrequent inundation events, although often short in duration, would inundate nearly 16,903 acres of woody wetlands (including depressional and other wetland habitats) with just an increase of one foot of water above 87 feet NGVD (D. Johnson, MVK, Personal Communication).

5.1 Focal Bird Species from IPaC and BoCC Analyses

Common Ground Dove

The Common Ground Dove (*Columbina passerina*) is the smallest dove endemic to the U.S. (Bowman 2020). Known largely in the extreme portions of southwestern and southeastern United States, south into Mexico and Central America, this species is rarely observed in the Yazoo Study Area. Moreover, the USFWS lists this bird as a species of conservation concern in two Bird Conservation Regions (BCR): The Southeastern Coastal Plain (BCR 27) and Peninsular Florida (BCR 31). The Yazoo Study Area is located within BCR 26; therefore, this species is not of conservation concern within the Study Area. This species also utilizes open areas interspersed with shrubs (Bowman 2020). Such habitats are not abundant in the Yazoo Study Area, thus the likelihood of impacts from the Proposed Plan construction and operation are estimated to be low.

> eBird Observations: Within the Yazoo Study Area, eBird includes 14 known detections of the Common Ground Dove during 2010 and 2012. Thirteen of the detections were in the Panther NWR and another at the Yazoo Valley Wildlife Area. Detections were between one and five individuals and occurred mostly during the late fall or winter.

Eastern Black Rail and Clapper Rail

The Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) and Clapper Rail (*Rallus crepitans*) utilize salt marsh, freshwater marsh, and/or estuarine marsh habitats. The eastern population of Black Rail is currently proposed for federal listing under the ESA. Along the Eastern Coast, populations of the Black Rail have declined significantly (approximately 9% annually; Watts 2016), likely due to habitat loss from sea level rise and nest inundation in tidal fresh water marshes (Watts 2016, Smith et al. 2018, USFWS 2018). Importantly, inland populations of this species in North Carolina have virtually disappeared (Smith et al. 2018). Habitat loss on inland freshwater marshes from conversion to agriculture, plus increase of predation in fragmented habitats are thought to be drivers of population decline. The Yazoo Study Area likely has few, if any, Black Rails because of their rarity as well as the overall lack of emergent marsh habitat. Lack of emergent marsh would suggest Clapper Rails also are rare within the Yazoo Study Area. Therefore, impacts on both rail species are considered to be low. It is possible to create freshwater impoundments with dense emergent vegetation that provide the critical year-round vegetative cover required by this and other rail species and provide suitable breeding habitat in the future (Smith et al. 2018, USFWS 2018, Eddleman et al. 2020). Furthermore, though flooding extent and duration will be reduced in a large portion of the Yazoo Study Area, precipitation inputs shown to sustain wetlands in the Yazoo Basin (Berkowitz et al. 2019) in addition to local flooding events will still occur after implementation of the Proposed Plan. Such events may provide opportunities for wetland and marsh restoration that would benefit these species, as well as other waterbirds, including colonial nesters such as herons and egrets, and migratory shorebirds. Creation or enhancement of emergent marsh habitat as part of mitigation in the Proposed Plan would provide significant benefits to a rails and a variety of other waterbirds.

> eBird Observations: The Eastern Black Rail has not been detected in the Yazoo Study Area. A frequency of occurrence between 0% - 2% for the Black Rail around McGehee, Arkansas, which is approximately 60 miles northwest of Rolling Fork, Mississippi, is documented in eBird. Similarly, there are no documented observations of the Clapper Rail in, or within the vicinity of, the Yazoo Study Area.

Whooping Crane

The Whooping Crane (*Grus americana*), a federally endangered species, breeds in Wood Buffalo National Park, Canada, and winters in southeastern Texas. It would be considered a vagrant outside of its typical wintering range (Teitelbaum et al. 2016) and migration corridor through the central Great Plains. The eastern population of Whooping Cranes is considered an experimental population that is listed as "threatened" under the ESA. This population may pass through the Yazoo Study Area as it migrates towards its primary wintering grounds in Florida (Urbanek and Lewis 2020). This species utilizes open grasslands, grassy marshes and wetlands. Because this species is considered a rare vagrant in the Yazoo Study Area, we do not anticipate any significant adverse impacts associated with the Proposed Plan.

> eBird Observations: There are no documented observations of Whooping Cranes in the Yazoo Study Area. A 0% - 10% frequency of occurrence around Lake Village, Arkansas, just west of the Yazoo Study Area is indicated, and these are likely northbound or southbound individuals from the Wood Buffalo population.

Shorebirds

We identified numerous shorebirds in the IPaC analysis as potentially occurring within the Yazoo Study Area, including the American Golden Plover (*Pluvialis dominica*), Piping Plover (*Charadrius melodus*), Marbled Godwit (*Limosa fedoa*), Ruddy Turnstone (*Arenaria interpres*), Semipalmated Sandpiper (*Calidris pusilla*), Red Knot (*Calidris canutus*), Dunlin (*Calidris alpina*), Short-billed Dowitcher (*Limnodromus griseus*), Willet (*Tringa semipalmata*), and Lesser Yellowlegs (*Tringa flavipes*). The Piping Plover is a federally listed species for three distinct breeding populations along the Atlantic Coast, in the Great Plains, and around the Great Lakes. Individuals from the endangered Great Lakes population are the most likely to pass through the Yazoo Study Area during migration. The Red Knot was federally listed under the ESA as threatened in 2014. This listing largely pertains to migratory birds along the Atlantic Coast. Most of these species could potentially occur for brief periods during the fall and/or spring migration seasons, but are unlikely to winter in the Yazoo Study Area. Most all of these shorebird species have experienced long-term population declines and are species of concern in the Gulf Coast region. However, the construction and operation of the Proposed Plan are expected to have little or no impacts on sediment-based coastal or riverine habitats, and are therefore unlikely to affect these species. As noted below, there are frequent detections of some of the non-ESA shorebird species within the Yazoo Study Area. These birds may benefit from large flooded areas that provide exposed or shallow mud- or sand-flats. Operation of the Proposed Plan may significantly reduce such habitats during flood events, thereby negatively impacting these species during migration seasons. However, at elevation 87 feet (NGVD) more than 120,000 acres are flooded. Wetland impoundments, such as MSM units, could be created to offset habitat losses if opportunities exist. Such impoundments should be located in former agricultural fields and should not serve to further fragment existing forested habitats (see Management Section below for more details).

eBird Observations: There have been no observations of federally listed Piping Plovers or Red Knots in the Yazoo Study Area; however, there have been documented detections of these species on the west side of the Mississippi River in Arkansas, close to the Yazoo Study Area, where riverine sandbar and island habitats are plentiful. The Semipalmated Sandpiper is the most common species from this group detected in the Yazoo Basin with hundreds of observations since 2002; many individual observations of hundreds of birds have occurred on the Yazoo NWR, Panther Swamp NWR, Tara Wildlife facility, Shipland WMA, various private lands, and other locations between 2002 and 2018. Dunlin, Short-billed Dowitchers, and Lesser Yellowlegs are the next most common species, with individual birds and flocks of dozens and up to hundreds of detections between 1999 and 2019 on the previously mentioned WMAs and NWRs, plus Morgan Brake NWR; also including ponds and catfish ponds in and around Mahannah WMA and Indianola, Mississippi, and various private lands. The American Golden Plover, Marbled Godwit, and Ruddy Turnstone are less common, with most observations of one to several individuals on the aforementioned NWRs and WMAs, ponds, catfish ponds, and private areas throughout the Yazoo Study Area from 2003 to 2020. Most observations of all of these species occurred during the late summer and fall, with fewer observations occurring during early spring.

Interior Least Tern

The Least Tern (*Sternula antillarum*) is a riverine or coastal seabird that utilizes sandy or rocky beaches and shorelines for nesting, foraging, or roosting. The Interior population of Least Tern (*S. a. athalassos*) is federally listed as endangered, however, but is currently awaiting a final delisting Rule for removal from ESA protection due to recovery. Interior population birds usually breed on sandbars and dredged-material islands. Some use of backwaters, marshes, and borrow areas may occur while foraging during the breeding season. However, this species almost never utilizes forested habitats, and therefore, impacts on these species from the construction and operation of the Proposed Plan in the Yazoo Study Area are considered very low.

eBird Observations: Most observations are documented just west of the Yazoo Study Area along the Mississippi River. Scattered observations of Least Terns have occurred in the Yazoo Study Area between 2002 and 2020, particularly at the Shipland WMA, and various ponds, catfish ponds, and other private locations. Most observations were between 2 and 20 individuals, except the observation of 186 individuals at the Itta Bena, Mississippi, catfish ponds in 2018, and most occurred during the mid- to late summer period near or after the breeding season. In years when the Mississippi River is near or at flood stage, and nesting habitat is flooded, individuals will move off-river to seek alternate nesting sites. Some of the aforementioned sightings could have been in that category.

Wood Stork

The Wood Stork (*Mycteria americana*) is an endangered species that periodically moves through the Lower Mississippi Basin (Coulter et al. 2020). During most of the year, it largely resides and

breeds in Florida. There are some small breeding populations in Georgia and South Carolina, as well as some breeding populations in Mexico, Central and South America, Cuba and other islands (Coulter et al. 2020). This species is not a true migrant, but will move according to availability of the local food supply. A larger number of south Florida Wood Storks do move into central Alabama and northeastern Mississippi (i.e., Tombigbee Waterway in Alabama to Sam Hamilton NWR in Mississippi) but it is highly unlikely Wood Storks detected in the lower MAV are from the listed population (William B Brooks, USFWS Wood Stork Recovery Lead, personal communication, June 15, 2020). Wood Storks present at some time of the year in the MAV, including the Yazoo Study Area, are likely post-breeding individuals from Mexico (Coulter et al. 2020). However, there have been reports of attempted nesting by this species just north of Vicksburg, Mississippi (Mueller and McCabe 1997); therefore, there is the potential that individuals from the federally listed population of Wood Storks could breed, or attempt to breed in the Yazoo Study Area. Wood Storks forage in fresh and marine-estuarine forest habitats, and may breed in cypress swamps. Future breeding in the Yazoo Study Area is unlikely, but there will continue to be a high likelihood that non-breeding individuals from the Mexico population will occur in the Yazoo Study Area. In fact, two of the reports' authors (RF, JJ) observed Wood Storks in the Yazoo Study Area on two occasions while conducing fieldwork in 2020 (Six individuals foraging at the toe of the levee within one mile of the proposed pump construction site; 75 individuals flying and foraging near Rolling Fork, Mississippi). The construction and operation of the Proposed Plan is not anticipated to have significant adverse impacts on Wood Storks, though individuals from the wintering Mexico population may experience some loss of foraging habitat.

> eBird Observations: There are many scattered observations of Wood Storks documented in or near the Yazoo Study Area from 2002 to 2020, usually between 1 and 10 individuals, but some observations of flocks from 50 to over 100 individuals. Most observations were along the Mississippi River, just west of the Yazoo Study Area. Most observations occur during the late-summer and early fall. Also observed were six Wood Storks within a half-mile of the pump station site and a large flock of 75-100 Wood Storks in wetlands immediately north of Theodore Roosevelt NWR. These observations were reported into the eBird portal.

Swallow-tailed Kite

The Swallow-tailed Kite (*Elanoides forficatus*) is a long-distance migrant that breeds in the southeastern U.S. and winters in South America (Meyer 2020). These birds breed in tall forested wetland habitats associated with open areas needed to forage for small animals and insects. This species is known to occupy forested habitats in eastern Louisiana and western Mississippi, and likely breeds in some of the forested habitats along the Mississippi River and potentially in the Yazoo Study Area. However, the portion of the population nesting along the Mississippi River near or in the Yazoo Study Area is likely very small. Loss of forested habitats due to the Proposed Plan construction and hydrologic alterations subsequent to operation are estimated to have a low negative impact on this species.

> eBird Observations: Observations of the Swallow-tailed Kite in the Yazoo Study Area have only occurred in 2014 and 2018; one at Leroy Percy State Park and the other near

Bolivar, Mississippi, respectively. Other scattered observations near the Mississippi River, just west of the Yazoo Study Area. Most observations occurred during the early spring or late summer.

Bald Eagle

The Bald Eagle (*Haliaeetus leucocephalus*) is a rare breeder in the Lower Mississippi Basin, but a common winter resident that utilizes mature forested wetlands for roosting and foraging sites (Buehler 2020). While this species has been removed from ESA protection, it is still protected under the Bald and Golden Eagle Protection Act (1940) and the Migratory Bird Treaty Act (1973), as amended. The Bald Eagle will likely focus on habitat directly associated with main river systems, including the Mississippi River, and potentially the Yazoo River. Therefore, estimated impacts to this species resulting from loss or hydrologic alteration of forested wetland habitat associated with construction and operation are expected to be low. Potential for updated monitoring and/or mitigation could be expected should Bald Eagle populations continue to expand and there is an increase in detections within the Yazoo Study Area prior to project construction. Reforestation of wetland areas, and in particular rehabilitation of riverine riparian habitat, would provide potential benefits to Bald Eagles.

eBird Observations: There are many scattered observations of Bald Eagles in the Yazoo Study Area from 1996 to 2020. Observations were documented at the DNF, Yazoo NWR, Panther Swamp NWR, and numerous catfish ponds. Most observations ranged from one to five individuals, and most observations occurred during winter to early spring. However, some detections occurred during late summer and fall. To date, there are no indications of breeding pairs in the Yazoo Study Area, but breeding could be a possibility as the Bald Eagle population continues to expand.

Red-headed Woodpecker

The Red-headed Woodpecker (*Melanerpes erythrocephalus*) breeds in mature deciduous trees, and can be found in mature open upland and riparian forest. However, this species may also occur within parks, groves, agricultural lands, and suburban development (Frei et al. 2020). There is no documented reliance of this species on forested wetlands; any forested system with mature tree cavities may be used. This species experiences periodic population increases and decreases in abundance; the cause for these cycles is poorly understood (Frei et al. 2020). Currently, populations in the southeast are in steady decline. This species is an obligate cavity nester and is often in competition with other cavity nesters in forested habitats. Although this species is dependent on mature forested habitats for nesting, the species' tolerance and use of open areas makes the overall impact to this species low. Moreover, hydrologic alterations to forested systems in the Yazoo Study Area are not likely to significantly affect habitat use by this species.

eBird Observations: There are numerous scattered Red-headed Woodpecker observations throughout the Yazoo Study Area from 2012 to 2020, with most observations between and one and five individuals, and during all seasons of the year.

Red-cockaded Woodpecker

The Red-cockaded Woodpecker (*Dryobates borealis*) is a federally listed endangered species that utilizes Longleaf Pine (*Pinus palustris*) savannah habitat (Jackson 2020). This species is a rare breeder in central and south Mississippi, and there is no known Longleaf Pine habitat in the Yazoo Study Area. Therefore, the impact to this species due to the construction and operations of the Proposed Plan is considered very low.

> eBird Observations: No observations of the Red-cockaded Woodpecker are documented in the Yazoo Study Area. One bird was detected in the Cut-off Creek Ravines Natural Area, Arkansas, far west of the Yazoo Study Area, and another individual was detected in Madison, Mississippi, well southeast of the Yazoo Study Area.

Wood Thrush

Wood Thrush (*Hylocichla mustelina*) typically breed in large, mature forested systems, including forested wetland habitats (Evans et al. 2020). However, this species likely does not nest often in flooded cypress swamps or other forested wetland types that are flooded for long periods during the nesting season. During the two-week July field effort throughout the Yazoo Study Area, no detections were made of Wood Thrush. Because this species nests near or on the ground, and a large percentage of potential nesting habitat was flooded throughout most of the breeding season, the lack of detections was not surprising. If operation of the Red-cockaded Woodpecker Plan, as expected, reduce flooding extent and duration in many of the forested habitats within the Yazoo Study Area, then the subsequent growth of the understory may improve habitat for this and other forest birds that nest on or near the ground. The reduction in extent and duration of flooding in the Yazoo Study Area, particularly during March through June, will clearly be of benefit to Wood Thrush, and other near to ground-nesting species that rely on significant understory vegetation growth for cover.

> eBird Observations: Scattered observations of Wood Thrush occurred in the Yazoo Study Area, mostly between 2014 and 2020; most observations have been between one and three individuals. Some areas where detections occurred included DNF, Tara Wildlife facility, Mahannah WMA, Panther Swamp NWR, Sunflower WMA, and Morgan Brake NWR. Most observations occurred during early spring to mid-summer.

Golden-winged Warbler

The Golden-winged Warbler (*Vermivora chrysoptera*) breeds in higher elevations of the Appalachian Mountains and northeastern and north-central U.S. with a disjunct population occurring from southeastern Ontario and adjacent Quebec northwest to Minnesota and Manitoba. Wintering populations occur in Central and South America. The loss of wintering habitat in Central and South America and migratory habitat may also contribute to its decline. The golden-winged warbler is also known to hybridize with the blue-winged warbler. This imperiled songbird depends on forested habitats to provide food and water resources before and after trans-Gulf and circum-Gulf migration. Population declines correlate with both loss of habitat owing to succession and reforestation and with expansion of the blue- winged warbler into the breeding range of the golden-winged warbler.

Golden-winged Warblers are uncommon to the region and are likely only impacted by loss of

forested wetlands used as migratory stopover habitat during the fall and spring. This species is not listed in IPaC for any reaches in the Yazoo Study Area, but was included here because it is a notable USFWS BoCC. During spring migration, these birds utilize mid-story forest vegetation (Confer et al. 2020). During the fall, use of other habitats including scrub/shrub and herbaceous stands of ragweed (*Ambrosia* spp.) have been noted (Confer et al. 2020). The Proposed Plan should have little to no impacts on this species. However, nonstructural features such as reforestation efforts and mitigation that include scrub/shrub habitat would provide the opportunity to actively address this species habitat needs in the Yazoo Study Area.

eBird Observations: Only two observations of the Golden-winged Warbler are documented in the Study Area: one in 2002 at the Shipland WMA and another in 2014 in the Yazoo NWR. One observation was in the early spring and the other was in late fall.

Prothonary Warbler

The Prothonotary Warbler (*Protonotaria citrea*) is a cavity-nesting species dependent on forested wetland habitats (Nolan et al. 2020). This species is common to abundant in forested areas along the Mississippi River and in the Yazoo Study Area along forested rivers, creeks, oxbows, sloughs, and other depressional wetlands, especially those that hold water during the breeding season. Because of their dependence on these floodplain features, they are a good indicator species for many of the wetland-dependent birds in the Yazoo Study Area. The relative impacts of the Proposed Plan on Prothonotary Warbler (and other wetland- dependent birds) will depend on a) flooding frequency, extent and duration above elevation 87 feet (NGVD 29), b) local flooding and floodplain inundation from precipitation-driven flood events above 87 feet (NGVD 29) within the Yazoo Study Area, and c) the extent to which isolated wetlands and water bodies fill and hold water subsequent to these local events. The extent of inundated acres for 23 days within the spring (March through May) over the POR (D. Johnson, MVK, Personal Communication) suggests a loss of up to 23,500 acres of suitable inundated forested habitat with the Proposed Plan, much of which would be expected to also be suitable for water- and wetland-dependent birds. A more detailed analysis is needed to fully map riverine floodplain features that would hold water after localized flooding events to better assess impacts. The 23-day duration analysis represents a conservative starting point for assessing overall impacts, but there is an unrealized habitat gain in bottomland hardwoods inundated by local flooding events that would reduce the currently assessed level of impact.

eBird Observations: Many observations of Prothonotary Warblers are documented in the Yazoo Study Area, particularly in the DNF, Yazoo NWR, Panther Swamp NWR, Mahannah WMA, and Sky Lake WMA. Most observations dated between 2000 and 2020, and most detections ranged from one to eight individuals. Detection dates are mainly in the early spring, but some observations are in the late summer to early fall.

Kentucky Warbler

The Kentucky Warbler (*Geothlypis formosa*) is a Neotropical migrant found in upland and forested wetlands in the southeastern and mid-Atlantic regions of the United States (McDonald 2020). Its northern extent can reach into the Great Lake states. Population density decreases southerly and this species is uncommon to rare along the extreme southern portions of MAV. This species requires dense ground and understory cover for nesting (McDonald 2020), a feature that may not be present in bottomland hardwood systems that are flooded for much of the year. Therefore, this species, in addition to the Wood Thrush (see above) and others, may benefit when flood extent and duration in forested habitats within the Yazoo Study Area are reduced. Reducing flood events will promote growth of the understory, likely increasing the breeding habitat for this species.

eBird Observations: Scattered observations of Kentucky Warblers in the Yazoo Study Area, with most at the DNF, Mahannah WMA, and Yazoo NWR. Most observations occurred between 2010 and 2020, and most detections were of one to three individuals during the early spring. During the July 2020 field investigations only a single singing male Kentucky Warbler was detected across much of the DNF, further suggesting very low abundance in the Yazoo Study Area.

Cerulean Warbler

The Cerulean Warbler (*Setophaga cerulea*) was proposed for federal listing in 2000 under the ESA, but is not currently listed. In 2006, the USFWS found that the Cerulean Warbler listing petition was not warranted. This species has experienced significant population declines throughout its North American breeding range (Buehler et al. 2020), and is likely a rare breeder in the MAV. There are known, but uncommon, breeding pairs in forested habitat along the Mississippi River in north Mississippi and south Arkansas (Buehler et al. 2020). Because this species is so rare in the Yazoo Study Area, and the Proposed Plan proposes only to remove forested habitat from a small footprint for construction, few to no impacts are expected.

eBird Observations: Two observations of Cerulean Warblers: one in 2014 at the Mahannah WMA in early spring, and another in the DNF, during early spring in 1992. Both observations were likely of transient migrants and not of breeding individuals.

Prairie Warbler

The Prairie Warbler (*Setophaga discolor*) is an early-successional species that utilizes open areas with dense shrubs (Nolan et al. 2020). This species is common to abundant in vacant old fields and pastures along the Mississippi River, but will utilize any scrub-shrub habitat in the Yazoo Study Area if available. While the Proposed Plan construction and operation will have little to no impact on current breeding populations of this species, there could be habitat gains for this and other early-successional species. If agricultural lands are selected for mitigation, and replanted with hardwoods, these sites will undergo succession. During the five to ten years following planting, there will be abundant woody shrub and sapling habitat that is preferred by Prairie Warbler and many other early-successional birds, but such areas may have limited benefit for this and other early-successional species if flooded regularly, or intermittently for long durations.

eBird Observations: Only two observations of Prairie Warblers have occurred in the Yazoo Study Area: one in the DNF in May, 2014, and the other at the Phillip Bros. catfish ponds in early April, 2017. Detections of this, and other early-successional species, are expected to increase significantly upon implementation and operation of the Proposed Plan and agricultural lands are selected for mitigation.

Henslow's Sparrow and LeConte's Sparrow

The Henslow's Sparrow (*Centronyx henslowii*) and the LeConte's Sparrow (*Ammospiza leconteii*) are overwintering species that utilize open grassland, pasture, and scrub-shrub habitat (Herkert et al. 2020, Lowther 2020). Secretive and likely not common in the Yazoo Study Area, the construction and operation of the Proposed Plan is not likely to impact these species. Decreased flooding in open areas after implementation of the Proposed Plan may enhance habitat for this species. As with Prairie Warbler, new early-successional habitat created on mitigation lands may not benefit these species if flooded regularly.

> eBird Observations: Only one observation of Henslow's Sparrow has occurred when four individuals were documented in the Panther Swamp NWR during the winter of 2009. Several observations of LeConte's Sparrow in the Yazoo NWR occurred during the late fall and early winter of 2017-2019, and one to two individuals were detected in the Mahannah WMA during the late fall and early winter from 2012 to 2013.

Rusty Blackbird

The Rusty Blackbird (*Euphagus carolinus*) is a wintering species in the southeastern U.S. that often spends the winter months in forested woodlands and wetland habitats in the MAV (Avery 2020). In addition, these birds are also found wintering in the southeastern Coastal Plain of the Carolinas and Georgia (Niven et al. 2004, Hamel and Ozdenerol 2009). Rusty Blackbirds forage in small flocks on the ground in primarily wet areas including flooded woods, swamps, and marshes (Avery 2020). They are not exclusive to forested wetlands, and can be found in a variety of other habitats including wetland edges, open pasture, agricultural fields, and even fields and parks (Luscier et al. 2010, Avery 2020). Frequently flooded bottomland hardwoods that remain shallowly-flooded during winter will provide viable habitat for this species. The same is true for inundated floodplains when either localized precipitation or flooding in riverine systems fills depressional areas.

> eBird Observations: Numerous scattered observations of the Rusty Blackbird during the late fall to winter months throughout the Yazoo Study Area. Most observations are of small flocks ranging from a few individuals to larger flocks of 30 to 50, and some over 100 birds. Most observations have occurred between 2009 and 2020, at Panther Swamp NWR, DNF, Yazoo NWR, Muscadine Farms WMA, and Mahannah WMA, plus numerous detections on private lands.

5.2 Incidental Bird Observations in DNF During Summer 2020

During avian sampling incidental to 2020 summer fieldwork, 47 species were detected at 53 discrete sampling points distributed throughout the Yazoo Study Area (Table 3). Overall, Acadian Flycatcher (*Empidonax virescens*), Carolina Wren (*Thryothorus ludovicianus*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*), and Yellow-billed Cuckoo (*Coccyzus americanus*) were the most commonly detected species with all five species detected at > 50% of points. Numerous species were detected at HEP points that are dependent on floodplain environments including Great Blue Heron (*Ardea herodias*), Little Blue Heron (*Egretta caerulea*), Great Egret (*Ardea alba*), White Ibis (*Eudocimus albus*), Belted Kingfisher (*Megaceryle alcyon*), and Wood Duck (*Aix sponsa*). Additional notable observations of water-

and wetland-dependent species detected within the Yazoo Study Area included Red-winged Blackbird (*Agelaius phoeniceus*), Wood Stork, Double-crested Cormorant (*Phalacrocorax auritus*), Roseate Spoonbill (*Platalea ajaja*), Anhinga (*Anhinga anhinga*), Black-bellied Whistling Duck (*Dendrocygna autumnalis*), Greater Yellowlegs (*Tringa melanoleuca*), Killdeer (*Charadrius vociferus*), and Snowy Egret (*Egretta thula*). Only one Kentucky Warbler, and no Wood Thrush, were detected during the two-week sampling period, further supporting the notion that prolonged flooding well into the breeding season for these species, along with the lack of habitat structure presumably due to inundation, largely eliminates them from the breeding bird community in much of the DNF.

5.3 Analysis of Focused Mitigation and Easement Lands

GIS and aerial imagery were used to identify 18 discrete habitat blocks, consisting of approximately 6,500 acres that would be highly beneficial as easement or mitigation lands for connecting larger blocks of forest that will provide important landscape linkages and movement corridors (Figure 3). These locations were further grouped into seven corridors for connecting larger tracts of forest (Figures 4 and 5). Two sites that are lower in elevation (Sites 4 and 7) would be high priority as these sites could serve as wetland mitigation sites where hydrologic functions could be restored (Figure 4). Both sites were still partially inundated during field visits in mid-July with numerous wading birds (e.g., Great and Snowy Egrets) and migratory shorebirds (e.g., Greater Yellowlegs) present. Sites 1-3 would serve as critical wildlife corridors to connect large forested tracts between the Mississippi River and DNF. Sites 4-7 would serve as corridors to connect larger tracts of forest as well as connecting DNF to Panther Swamp NWR (Figures 3 and 4). Site 4 also contained a large Snowy Egret rookery on the edge of forest and immediately adjacent to a small depressional area still fully inundated during the July 2020 field visits.

6.0 DISCUSSION

In general, most BoCC within the Yazoo Study Area identified by our IPaC analyses should experience few negative impacts with implementation of the Proposed Plan. This includes several species that have breeding or non-breeding ranges within only a relatively small proportion of the Yazoo Study Area, or that occur as transient migrants during spring and fall. Such species include Cerulean Warbler (rare breeder in Yazoo Study Area), Swallow-tailed Kite (rare breeder in Yazoo Study Area), U.S. breeding population of the Wood Stork (very rare breeder in this region), and Golden-winged Warbler (uncommon to rare and likely only use small portion of the Yazoo Study Area during migration). The impacts to Red-headed Woodpecker are minimal, and attributable to removal of mature forest resulting in a loss of potential nesting habitat during pump station construction; however, this species readily utilizes open areas and will likely be unaffected since direct impacts to habitat will be relatively small.

For other migratory birds, the footprint associated with pump station construction is small, and thus we anticipate few if any significant direct impacts to migratory birds. Even though construction of the pump station which includes associated access roads and right-of-ways, could remove up to 112 acres of forest and forested wetland habitat, the proposed mitigation or acquisition of easement lands outlined in the Proposed Plan will offset these

losses. Though replanted mitigation sites will not replace lost habitat structure and functions for approximately 50 years, there are incremental benefits realized each year of the project life resulting from successive suites of migratory bird species that exploit each successive successional vegetation community as sites trend from sapling/shrub communities to old-growth forest. This is particularly true for those species that utilize shrub habitat during approximately the first two to five years after replanting. Multiple early-successional species, including several migratory BoCC, will benefit from these early-successional mitigation areas include breeding Prairie Warblers (*Setophaga citrea*), Yellow-breasted Chats (*Icteria virens*), and Dickcissels (*Spiza americana*), and over-wintering Henslow's Sparrows and LeConte's Sparrows.

Construction and removal of habitat for the pump station will have moderate indirect impacts to some forest-dwelling BoCC associated with small-scale forest habitat fragmentation. Forest fragmentation may reduce reproductive success and alter the composition of bottomland forest communities by increasing predation rates along forest edges and by decreasing presence of birds that require forest interior habitat (Robinson et al. 1995). Species that are generalists in their habitat selection and are known to utilize edge habitat may displace forest interior dependent species and can act to recruit more edge species to the area. In this way, forest fragmentation of intact forests may have long-term adverse impacts on forest bird communities (Betts et al. 2017, Valente and Betts 2018). To minimize impacts to migratory birds, especially those that require large intact forests, efforts should be made to minimize to the extent practicable the footprint of forest habitat removal. In addition, construction should take place, to the extent practicable, between approximately 1 August and 28 February to minimize impacts to nesting migratory birds. State-specific time frames should be obtained from the local Service office and state conservation agency.

Pump operations are not expected to begin until the water level rises at the Steele Bayou structure above 87 feet (NGVD 29). For the 42-year POR of the current draft supplement to the FSEIS (1978-2019), Steele Bayou and Little Sunflower River water elevations have met or exceeded a maximum elevation during spring of 87 feet (NGVD 29) approximately every other year (D. Johnson, MVK, Personal Communication) meaning that unless future hydrology within the Mississippi and Yazoo River watersheds changes significantly, on average we expect that the No-Action Alternative conditions also would lead to flooding in the Yazoo Study Area above 87 feet (NGVD 29) every other year. When pump station operation is initiated in years when inundation levels reach or exceed 87 feet (NGVD 29), the water levels likely will not be significantly lowered below this threshold; at this threshold all or most depressional and other wetland habitats at and below 87 feet (NGVD 29) remain inundated. Though not an annual occurrence, these intermittent inundation events above 87 feet (NGVD 29) are important and likely occur at a frequency that assists in maintaining open-water, wetland-dependent and other bottomland hardwood bird communities and the habitats they rely on. Accordingly, during the POR, the average spring water elevation at Steele Bayou did not reach 87 feet (NGVD 29) for 11 of the 42 years (40.5%).

Bottomland hardwoods above elevation 87 feet (NGVD 29) that would receive reduced future flooding due to operation under the Proposed Plan will likely experience changes in habitat structure and function, and composition of flora and fauna. Changes resulting from altered hydrologic regimes will likely benefit species inhabiting more terrestrial habitats, while those species relying on periodic inundation could be negatively impacted to varying degrees.

For example, a reduction of flood frequency and duration in bottomland hardwood forests may positively influence migratory ground or near ground-nesting species such as Wood Thrush (*Hylocichla mustelina*), Hooded Warbler (*Setophaga citrina*) and Kentucky Warbler by allowing an increase in understory vegetation density and structure, thereby potentially increasing suitability of these habitats as breeding sites. Reduced flooding may also enhance habitat for forest birds that primarily forage on the ground, such as Wood Thrush and Swainson's Warbler (*Limnothlpis swainsonii*) (Reiley et al. 2017) and is an additional benefit of reduced flooding for some forest birds in the Yazoo Study Area. Species from our IPaC analyses most likely to be indirectly impacted by hydrologic changes within the overall Yazoo Study Area are those that are abundant within the Yazoo Study Area and utilize bottomland hardwood and floodplain forests extensively during the breeding or wintering seasons. These include Prothonotary Warbler and Rusty Blackbird, both of which are good indicator species for other water- and wetland-dependent species such as herons, egrets, and ibises. Prothonotary Warblers, that rely on forested wetlands during the breeding season, and which frequently were detected in the Yazoo Study Area adjacent to streams and depressional wetlands, would likely be negatively impacted to a degree by a decrease in inundated forest at elevations between 90.5 and 87 feet (NGVD 29) during late-winter and spring. Likewise, wading birds that utilize flooded areas for year-round foraging and breeding during the spring and summer also may be negatively impacted by reduced inundation. Migratory shorebird stop-over sites important for feeding also may be reduced or eliminated, especially in and along shallow inundated fields or other open areas where invertebrates often are plentiful. It is important to note here that, because these latter three species groups (primarily wading birds) were not included in IPaC outputs, we did not directly address impacts to them. Furthermore, based on the annual maximum inundation elevations for March through May, the historical POR shows that, (1) if the pump station had initiated operations in 1978, it would have been operational for approximately one of every two years through 2019; (2) the mean water elevation was 91.3 feet (NGVD 29) for the 24 years that Steele Bayou water elevations exceeded 87 feet (NGVD 29); and (3) the mean 30-day spring inundation for the full 42-year POR was 81.1 feet (NGVD 29) (D. Johnson, MVK, Personal Communication). These numbers suggest that the influence of the Proposed Plan on wetland habitats in the Yazoo Study Area will not be an annual event.

The direct and indirect impacts of the Proposed Plan on most of the species not included in the IPaC analyses for the Yazoo Study Area (e.g., herons, egrets, ibises) will depend on several factors warranting further investigation. First, it is essential to more thoroughly understand the flooding extent and duration above elevation 87 feet (NGVD 29) resulting from local precipitation events, and flood and floodplain inundation events either locally or as a result of rain within the larger watershed. Although the Proposed Plan is expected to reduce the acres of flooded habitat above 87 feet (NGVD 29) in one of every two years, floodplain inundation from precipitation-driven flood events will fill many isolated wetlands and water bodies (e.g., meander scars, sloughs, gravel bars, borrow pits, old depressions, and/or oxbows [Wharton et al. 1982]) independently of the Steele Bayou water control structure operation, and pump station operation. An undetermined number of these landscape features are hydrologically influenced by overbank flooding when local drainages (e.g., Little Sunflower River, Steele Bayou) receive local precipitation and inundate the floodplain (either by overbank flooding or via distributaries of these rivers). Furthermore, there are a multitude of these depressional floodplain features in the Yazoo Study Area that are inundated and will hold water

for long durations when the water control structure is closed. Some of these features are hydrologically connected to channels that allow them to drain when the water control structure is subsequently opened; yet some do not as an undetermined number of these features are isolated water bodies that, when inundated, retain water well into summer (if not longer) and do not drain. Though we currently do not have acreage estimates for these landscape features, these areas are likely significant for a diverse suite of bird species and should be included in future analyses.

Following our initial and independent assessment of targeted mitigation areas, we consulted Elliott et al. (2020) to determine if there was correspondence between their priority restoration sites and ours. Elliott et al. (2020) assessed the conservation–protection status of land within the MAV and prioritized the need for additional conservation–protection based on benefits to forest bird conservation afforded by forest patch area, geographic location, and hydrologic condition (Figure 5). They focused on habitat blocks of core forest greater than 2,000 hectares and more than 250 meters from an edge. Similarly, the Lower Mississippi Valley Joint Venture (LMVJV) partnership has long promoted strategic reforestation in the MAV for the conservation of breeding birds (Twedt et al. 1999). We found direct and high correspondence between the two independent assessments, suggesting these focal areas are of high conservation value for meeting the future needs of the regional avifauna.

Table 1. Total area inundated with respect to elevation (NGVD 29).

Elevation (feet NGVD 29)	Total Acres
80	9,443
81	11,972
82	14,867
83	18,553
84	24,462
85	32,015
86	44,214
87	57,918
88	79,843
89	105,795
90	136,133
91	168,488
92	195,389
93	224,779
94	258,447
95	292,911
96	331,860
97	376,959
98	422,852
99	463,029
100	506,144
101	544,024
102	583,998
103	625,583

Table 2. Migratory birds identified using the USFWS Information for Planning and Consultation (IPaC; USFWS 2020) and designated as threatened and endangered under the ESA, or USFWS Birds of Conservation Concern, which are known to regularly use or occupy habitats in the Yazoo Basin.

Species	Scientific Name	Status
Columbidae		
Common Ground Dove	*Columbina passerina*	BoCC[a]
Rallidae		
Eastern Black Rail	*Laterallus jamaicensis*	PT[b]
King Rail	*Rallus elegans*	BoCC
Gruidae		
Whooping Crane	*Grus americana*	FE[c]
Charadriidae		
American Golden Plover	*Pluvialis dominica*	BoCC
Piping Plover (wintering)[e]	*Charadrius melodus*	FT[d], FE
Scolopacidae		
Marbled Godwit	*Limosa lapponica*	BoCC
Ruddy Turnstone	*Arenaria intrepres*	BoCC
Semipalmated Sandpiper	*Calidris pusilla*	BoCC
Red Knot	*Calidris canutus*	FT
Dunlin	*Calidris alpina*	BoCC
Short-billed Dowitcher	*Limnodromus griseus*	BoCC
Willet	*Tringa semipalmata*	BoCC
Lesser Yellowlegs	*Tringa flavipes*	BoCC
Laridae		
Least Tern (Interior population)	*Sternula antillarum*	FE
Ciconiidae		
Wood Stork	*Mycteria americana*	FT
Accipitridae		
Swallow-tailed Kite	*Elanoides foricatus*	BoCC
Bald Eagle	*Haliaeetus leucocephalus*	BoCC
Picidae		
Red-headed Woodpecker	*Melanerpes erythrocephalus*	BoCC
Red-cockaded Woodpecker	*Picoides borealis*	FE
Falconidae		
American Kestrel	*Falco sparverius*	BoCC

Turdidae		
Wood Thrush	*Hylocichla mustelina*	BoCC
Parulidae		
Prothonotary Warbler	*Protonotaria citrea*	BoCC
Kentucky Warbler	*Geothlypis formosa*	BoCC
Cerulean Warbler	*Setophaga cerulea*	BoCC
Prairie Warbler	*Setophaga discolor*	BoCC
Emberizidae		
Henslow's Sparrow	*Ammodramus henslowii*	BoCC
LeConte's Sparrow	*Ammodramus leconteii*	BoCC
Icteridae		
Rusty Blackbird	*Euphagus carolinus*	BoCC

[a] BoCC: USFWS Bird of Conservation Concern (USFWS 2008)
[b] PT: Proposed as Federally Threatened
[c] FE: Federally Endangered
[d] FT: Federally Threatened
[e] Great Lakes population (FE); Northern Great Plains and Atlantic Coast populations (FT)

Table 3. Bird species detected at 53 HSI plots while collecting data for HEP analysis during a two-week period in mid-July, 2020 in the Yazoo Study Area.

	Borrow Area (n=7)		Delta NF (n-24)		Pump Station (n=11)		Theodore Roosevelt NWR (n=7)		Yazoo NWR (n=4)		Total (n=53)	
Bird Species	Number of Points Species Detected	% Presence of Points Visited	Number of Points Species Detected	% Presence of Points Visited	Number of Points Species Detected	% Presence of Points Visited	Number of Points Species Detected	% Presence of Points Visited	Number of Points Species Detected	% Presence of Points Visited	Number of Points Species Detected	% Presence of Points Visited
Acadian Flycatcher	2	29	22	92	1	9	1	14	2	50	28	53
American Crow	1	14	0	0	0	0	1	14	0	0	2	4
Barred Owl	0	0	2	8	0	0	0	0	0	0	2	4
Black and White Warbler	0	0	1	4	0	0	0	0	0	0	1	2
Belted Kingfisher	1	14	0	0	1	9	0	0	0	0	1	2
Blue-gray Gnatcatcher	1	14	7	29	1	9	1	14	0	0	10	19
Brown-headed Cowbird	1	14	1	4	0	0	1	14	0	0	3	6
Blue Jay	0	0	4	17	5	45	1	14	0	0	10	19
Carolina Chickadee	3	43	9	38	3	27	1	14	2	50	18	34
Carolina Wren	4	57	15	63	7	64	0	0	2	50	28	53
Chimney Swift	0	0	1	4	0	0	0	0	0	0	1	2
Dickcissel	0	0	0	0	1	9	0	0	0	0	1	2
Downy Woodpecker	2	29	4	17	0	0	1	14	1	25	8	15
Eastern Towhee	0	0	0	0	0	0	1	14	2	50	3	6
Eastern Wood Pewee	1	14	14	58	0	0	1	14	2	50	18	34
Great Blue Heron	2	29	2	8	1	9	0	0	0	0	5	9
Great-crested Flycatcher	0	0	3	13	0	0	0	0	0	0	3	6
Great Egret	0	0	3	13	0	0	0	0	0	0	3	6
Hairy Woodpecker	0	0	1	4	0	0	0	0	0	0	1	2
Hooded Warbler	0	0	3	13	0	0	0	0	0	0	3	6
Indigo Bunting	7	100	16	67	6	55	6	86	1	25	36	68
Killdeer	1	14	0	0	0	0	1	14	0	0	2	4
Little Blue Heron	0	0	3	13	0	0	0	0	0	0	3	6
Mississippi Kite	0	0	1	4	0	0	0	0	0	0	1	2

Mourning Dove	1	14	1	4	0	0	2	29	3	75	7	13
Northern Cardinal	5	71	17	71	9	82	7	100	3	75	41	77
Northern Flicker	0	0	0	0	0	0	0	0	1	25	1	2
Northern Parula	0	0	4	17	0	0	0	0	1	25	5	9
Orchard Oriole	1	14	1	4	0	0	0	0	0	0	2	4
Pileated Woodpecker	1	14	2	8	1	9	0	0	0	0	4	8
Prothonotary Warbler	2	29	11	46	3	27	2	29	0	0	18	34
Red-bellied Woodpecker	4	57	17	71	1	9	1	14	2	50	25	47
Red-eyed Vireo	0	0	14	58	0	0	0	0	0	0	14	26
Red-shouldered Hawk	0	0	1	4	0	0	0	0	0	0	1	2
Red-tailed Hawk	0	0	0	0	1	9	0	0	0	0	1	2
Ruby-throated Hummingbird	0	0	0	0	0	0	1	14	1	25	2	4
Red-winged Blackbird	3	43	0	0	2	18	2	29	0	0	7	13
Summer Tanager	3	43	12	50	1	9	0	0	0	0	16	30
Tufted Titmouse	0	0	22	92	0	0	1	14	1	25	24	45
White-breasted Nuthatch	0	0	1	4	0	0	0	0	0	0	1	2
White-eyed Vireo	2	29	20	83	0	0	1	14	1	25	24	45
White Ibis	0	0	5	21	1	9	0	0	0	0	6	11
Wood Duck	0	0	1	4	1	9	0	0	0	0	2	4
Yellow-breasted Chat	2	29	0	0	0	0	3	43	0	0	5	9
Yellow-billed Cuckoo	4	57	11	46	7	64	3	43	3	75	28	53
Yellow-throated Vireo	0	0	5	21	0	0	0	0	0	0	5	9
Yellow-throated Warbler	0	0	8	33	0	0	0	0	0	0	8	15
Total	54		265		53		39		28		439	

FIGURES

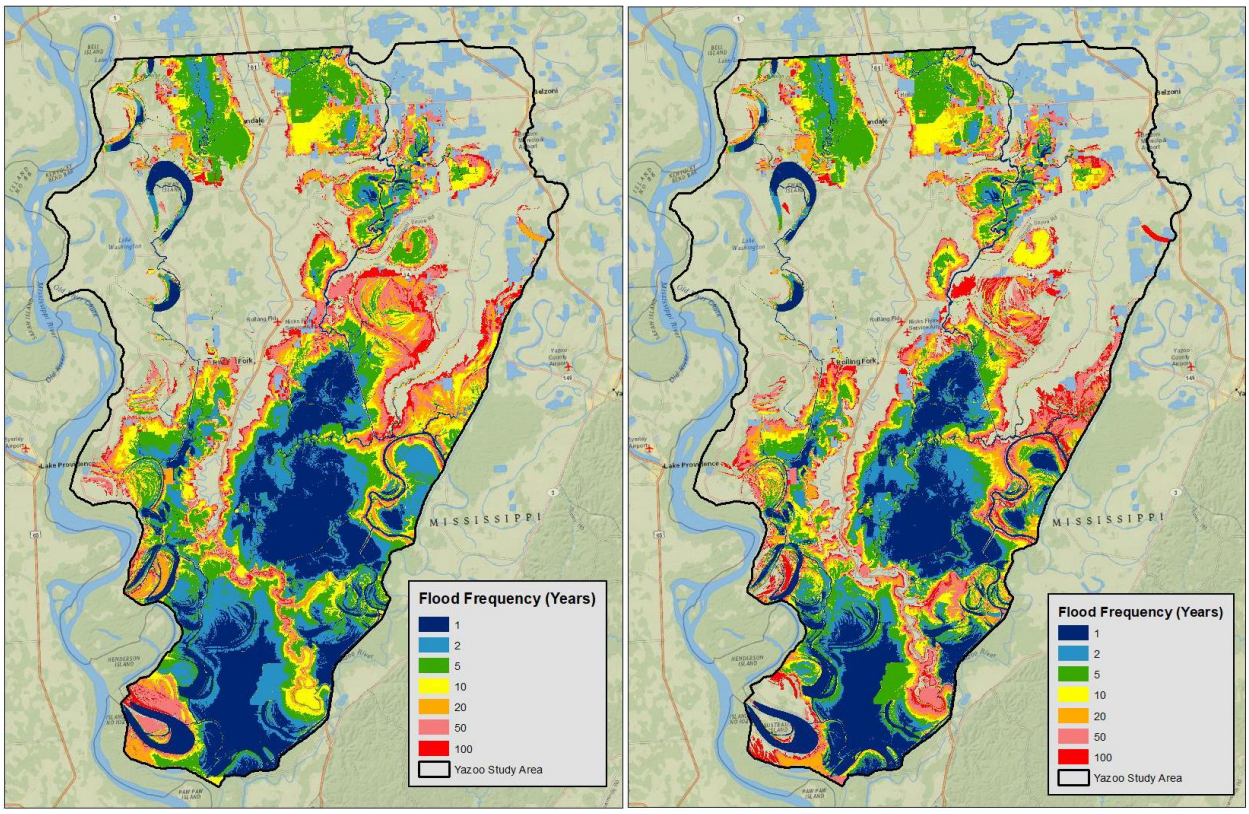

Figure 1. The modeled extent of inundation according to the 1, 2, 5, 10, 25, 50, and 100-year flood frequencies within the Yazoo Study Area for the POR between the No Action Alternative (left) and the Proposed Plan (right).

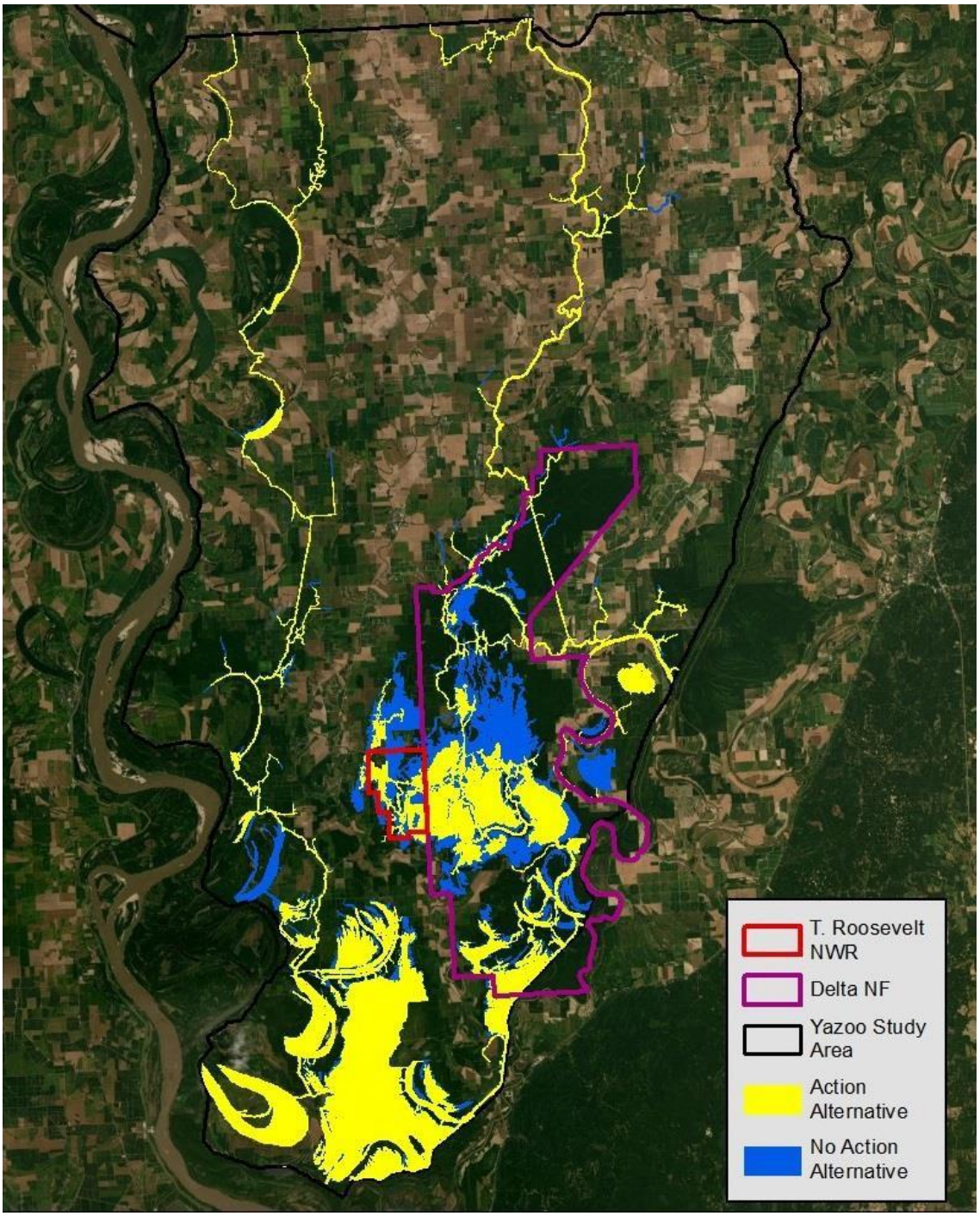

Figure 2. Areas within the Yazoo Study Area inundated for 23 days during spring (March-May) over the 42-year period-of-record.

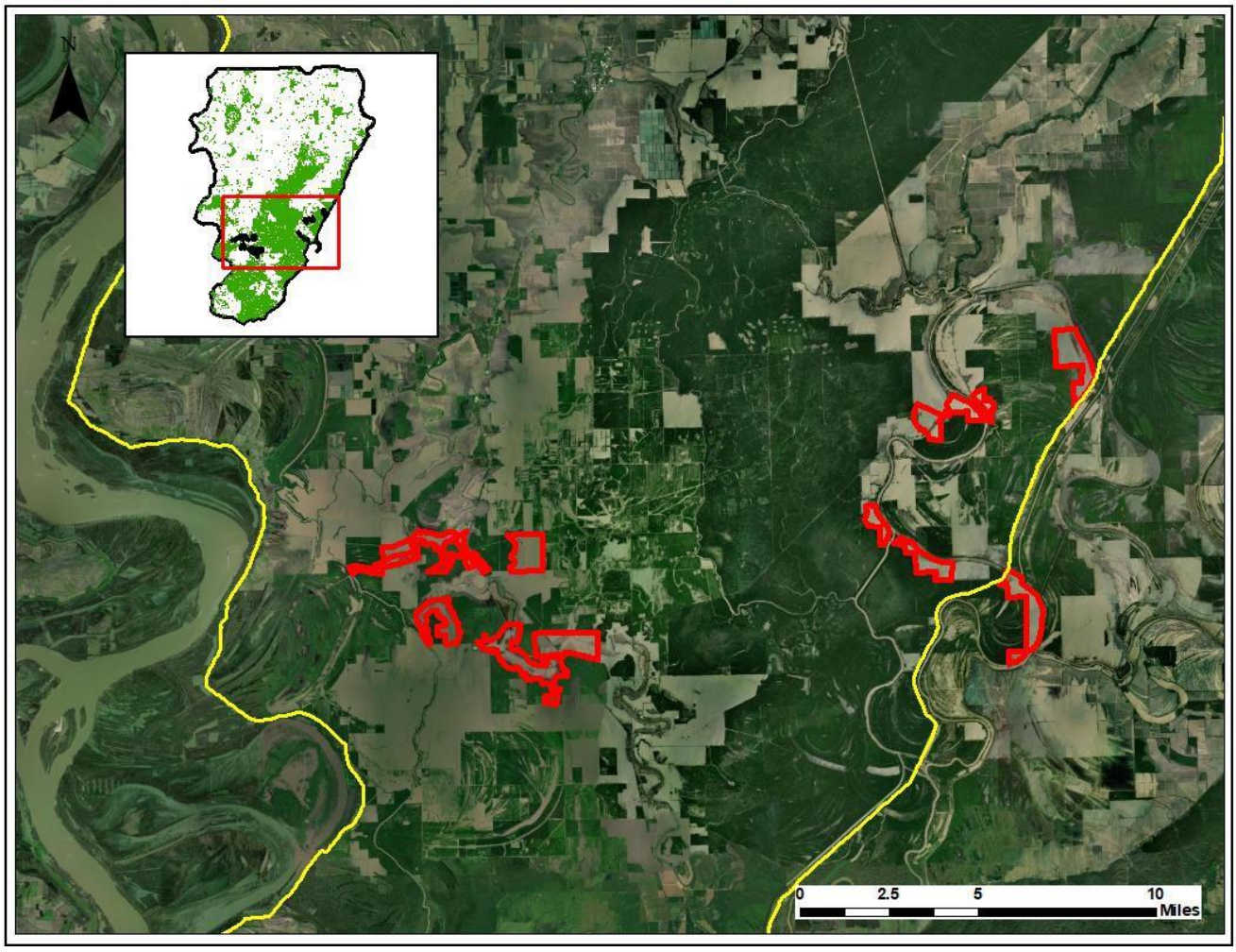

Figure 3. Recommended mitigation and conservation easement lands in the Yazoo Study Area.

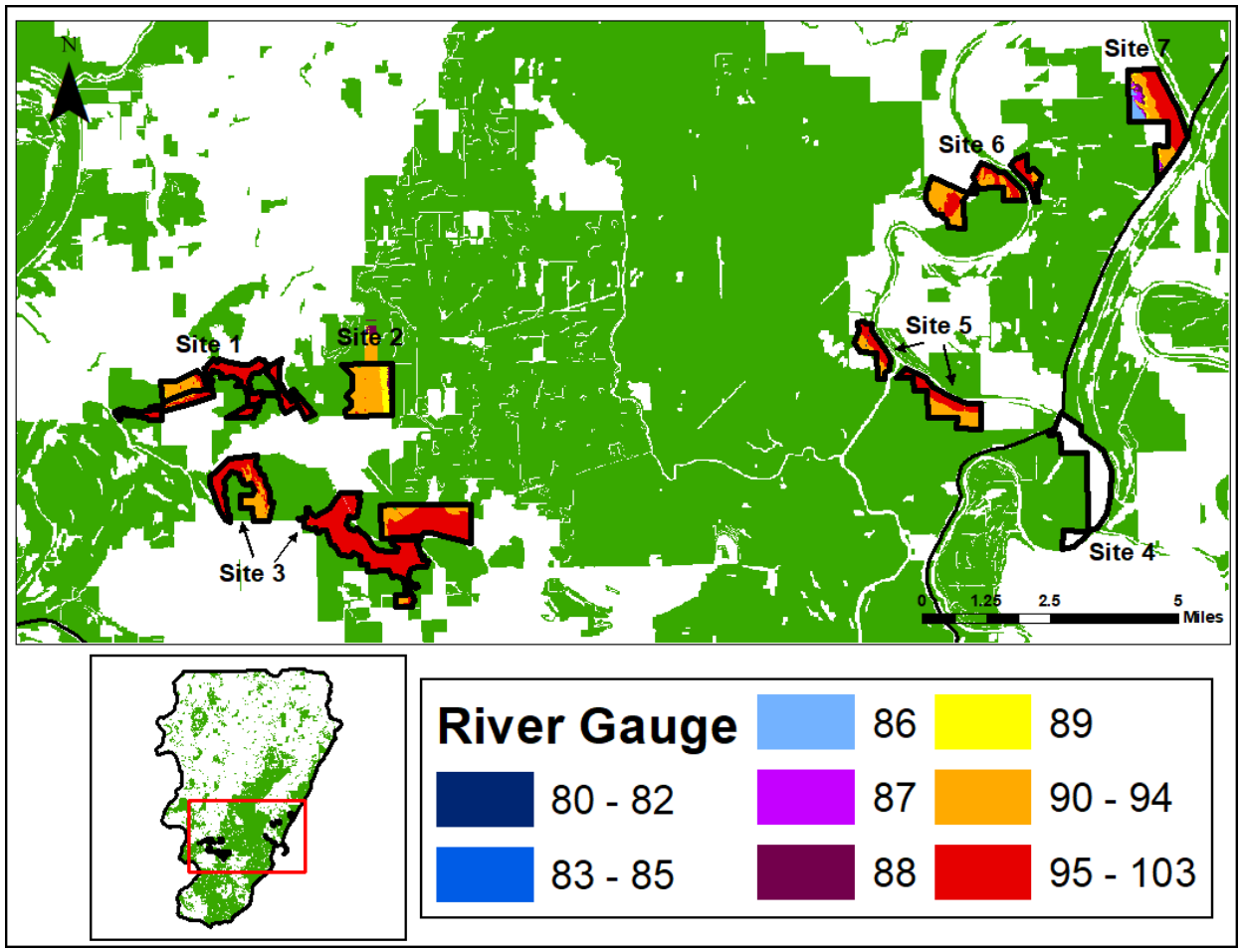

Figure 4. Potential sites for reforestation outlined for consideration in the Yazoo Study Area to connect existing forest blocks and serve as wildlife corridors. Numbers represent river gauge elevations at Steele Bayou in feet (NGVD 29).

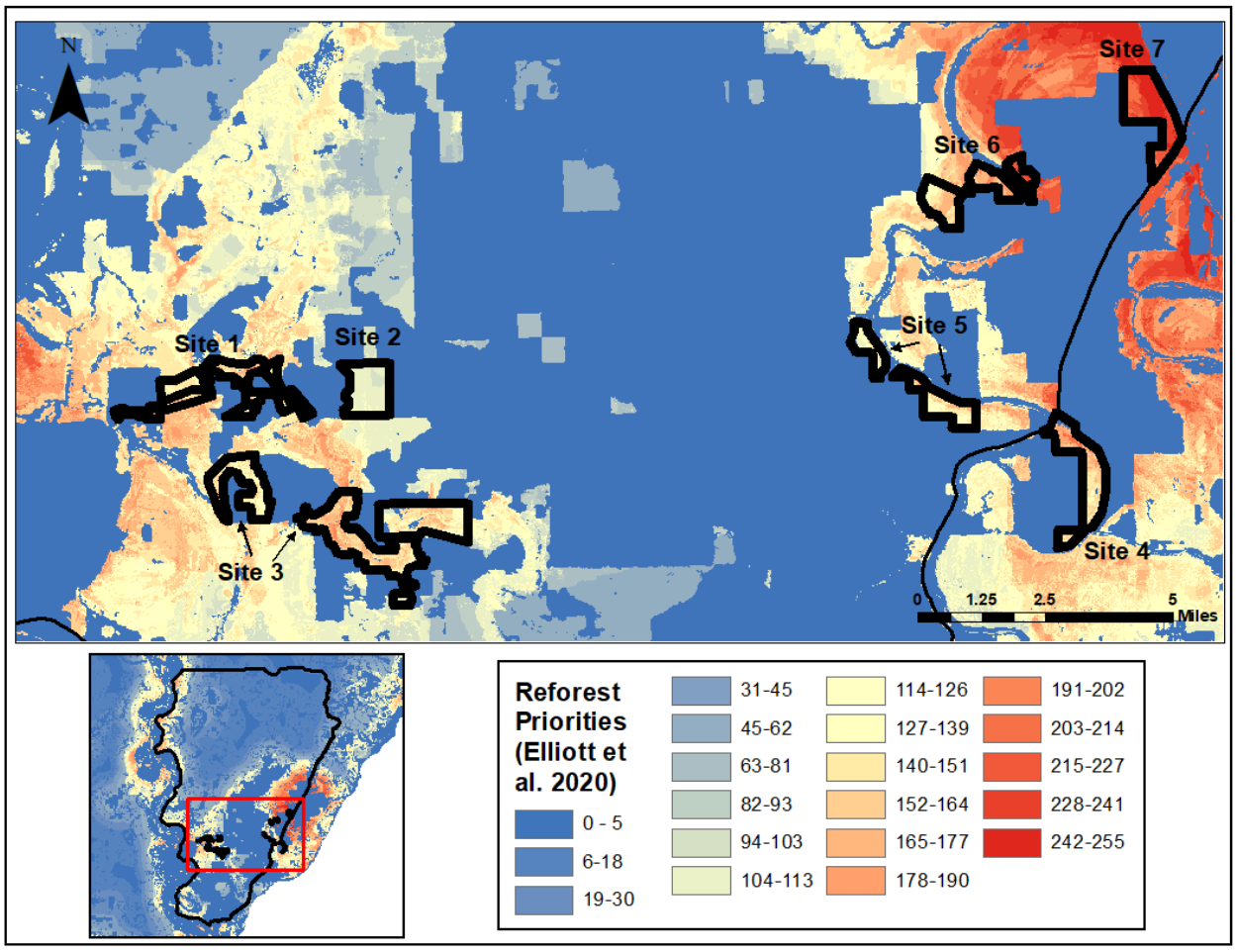

Figure 5. Reforestation priorities in the Yazoo Study Area as recommended by Elliott et al. 2020, with a gradient from low (blue) to high (red) for prioritizing areas to reforest.

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