APPENDIX 5
WATERFOWL ASSESSMENT (DUCK USE DAYS)

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A5-1 INTRODUCTION

Construction of some Work Items identified in the SEIS II would result in losses to available wintering waterfowl habitat within the Mississippi Alluvial Valley (MAV). To mitigate for these losses, a standard practice is to conduct a landscape analysis that provides an index of how many waterfowl an area can support according to food resources that are present within a particular habitat. This index refers to the number of duck-use-days (DUD) or simply the number of days a single individual duck could be supported based on the food resources available in that area. The most basic representation for DUD is the formula:

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

Where,

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

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

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

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

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

[1] True metabolizable energy (TME) is the amount of energy available to waterfowl from their diet
[2] Daily existence energy (DEE) is the number of kilocalories (kcal) an individual duck needs for one day
[3] Resting Metabolic Rate (RMR) accounts for conditions under which data are obtained from test animals, rather than implying a true basal rate of energy use

DUD calculations for the MRL-SEIS II is based on data and formulas within "A manual for calculating duck-use-days to determine habitat resource values and waterfowl population energetic requirements in the Mississippi Alluvial Valley," hereafter referred to as DUD manual (Heitmeyer 2010). This manual was developed in 2010 by M. Heitmeyer for outlining protocol for calculating the number of DUD in the MAV and follows general guidelines originally established by the Lower Mississippi Valley Joint Venture (LMVJV). This method has been used on USACE flood control projects to quantify the impact of altering hydrology on traditional waterfowl wintering areas and for designing appropriate mitigation measures (Heitmeyer et al. 2011, U.S. Army Corps of Engineers 2013) and the model for calculating DUD has been certified by USACE.

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

Historical Perspective

Historically, the MAV was composed of mostly bottomland hardwood forests (BLH), swamps, and bayous, including the largest forested wetland in North America (25 million acres), extending approximately from southeastern Missouri to southern Louisiana. Conversion of forest to agricultural land has resulted in over 80 percent of the forest in this region cleared. Historically, most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries; however, following the Flood Control Act of 1941, hydrologic relationships in the MAV were altered by federally funded water resource developments for flood control and agriculture (Reinecke et al. 1988). Despite these changes to the landscape and hydrology in the MAV, it remains a critical ecoregion for North American waterfowl and other wildlife (Kaminski 1999). Approximately 40 percent of the Mississippi Flyway's waterfowl, and 60 percent of all U.S. bird species either migrate through or winter in the MAV (LMVJV 2015). The MAV is considered the most important wintering location for mallard (*Anas platyrhynchos*) and Wood Duck (*Aix sponsa*) populations as well as wintering significant numbers of Green-winged Teal (*Anas crecca*), Northern Shoveler (*Spatula clypeata*), and Gadwall (*Mareca strepera*) (LMVJV 2015).

As the result of devastating floods (1912, 1913, 1916, and 1927), Congress enacted the comprehensive flood protection program called the Mississippi River and Tributaries Project (MR&T). Following construction of 1,500 miles of mainline levees along both banks of the Mississippi River under the MR&T Project, thousands of acres of BLH forests were cleared for agricultural production. Today, these lands are primarily used for the production of cotton, soybeans, rice, and corn. The BLH that remain along the Mississippi River are among the nation's most important wetlands. Land cover information provided by Geographic Information System (GIS) mapping of the batture lands (those lands riverside of the mainline levees) indicates that there is approximately 281,000 total acres within the MRL-SEIS II Work Items, of which, approximately 51,000 acres are forested and 80,000 acres are in agricultural croplands. These forested wetlands fulfill special waterfowl habitat requirements not provided by open lands. Wooded habitats produce nutritious foods for waterfowl and provide secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation.

Habitat Requirements

The loss and degradation of habitat have been identified as the major waterfowl management problem in North America (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). Habitat requirements for wintering waterfowl include three components: availability, utilization, and suitability in meeting social behavioral requirements. Size of the migratory waterfowl population in the MAV is a direct function of these three components. Managed and unmanaged wintering waterfowl habitats are present in the MAV. Managed habitats, using structural measures and vegetation manipulation, are primarily found on Federal and State lands, and represent the core wintering habitat during dry (below normal rainfall) years. Temporary and seasonal wetlands tend to be large producers of waterfowl food supplies. Unmanaged winter habitat provides important foraging habitat to wintering waterfowl during years of normal or above normal rainfall. These periods of above normal rainfall show increases in available foraging habitat from 900 percent in Mississippi to 1,200 percent in Arkansas (Reinecke et al. 1988). The increased availability of wintering habitat also affects the distribution of wintering waterfowl in the MAV. Proportionately more waterfowl have been found to winter in the MAV during periods of above normal rainfall (Nichols et al. 1983, Reinecke et al. 1987). However, unmanaged and flood susceptible habitats within the MAV, which are important to wintering waterfowl, have long been subject to Federal flood control drainage projects that have altered the historic flood events.

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

Population Status

Within North America, several species of waterfowl, including mallards, are showing signs of recovery approaching or exceeding the population levels recorded in the 1950s (Annual Breeding Duck Survey). Total duck abundance was 38.9 million birds, an increase of 10 percent higher than the 1955-2018 average (Attachment 1). A comparison of average total duck numbers of 37.4 million for 1955-1960 to that of 45 million ducks during 2015-2019 resulted in ~20 percent increase (U.S. Fish and Wildlife Service [USFWS] 2019). Long-term trends generally display an increase in populations for mallards, Gadwalls, Green-winged Teal, Blue-winged Teal (*Spatula discors*), Northern Shoveler, and Redheads (*Aythya americana*). Northern Pintails (*Anas acuta*) and Scaup (*Aythya* spp.) have yet to recover from long-term averages, while Canvasback (*Aythya valisineria*) and American Wigeon (*Mareca americana*) populations appear to have remained relatively stable over time (Figure A5-1).

While the annual breeding duck surveys are the most reliable estimates of waterfowl populations, population estimates are also available from extensive surveys of wintering ducks as well as waterfowl harvest data. The midwinter waterfowl survey for the Mississippi Flyway, conducted by the USFWS and the states, is an attempt to count the total number of ducks of each species (Attachment 1). Total duck abundance was 5.75 million birds, a decrease of 14 percent over the long-term average (1955-2018). However, the midwinter average population estimate for the past decade (2011-2020) was ~7.5 million ducks, an increase of nearly 12 percent over the long-term average (Table A5-1; Fronczak 2019). Caution must be taken when considering midwinter counts, as these population estimates are not considered reliable for measuring trends in abundance of most duck species because of the large area that must be surveyed, and the difficulty of counting birds, especially in wooded habitats, and the lack of a valid statistical sampling scheme.

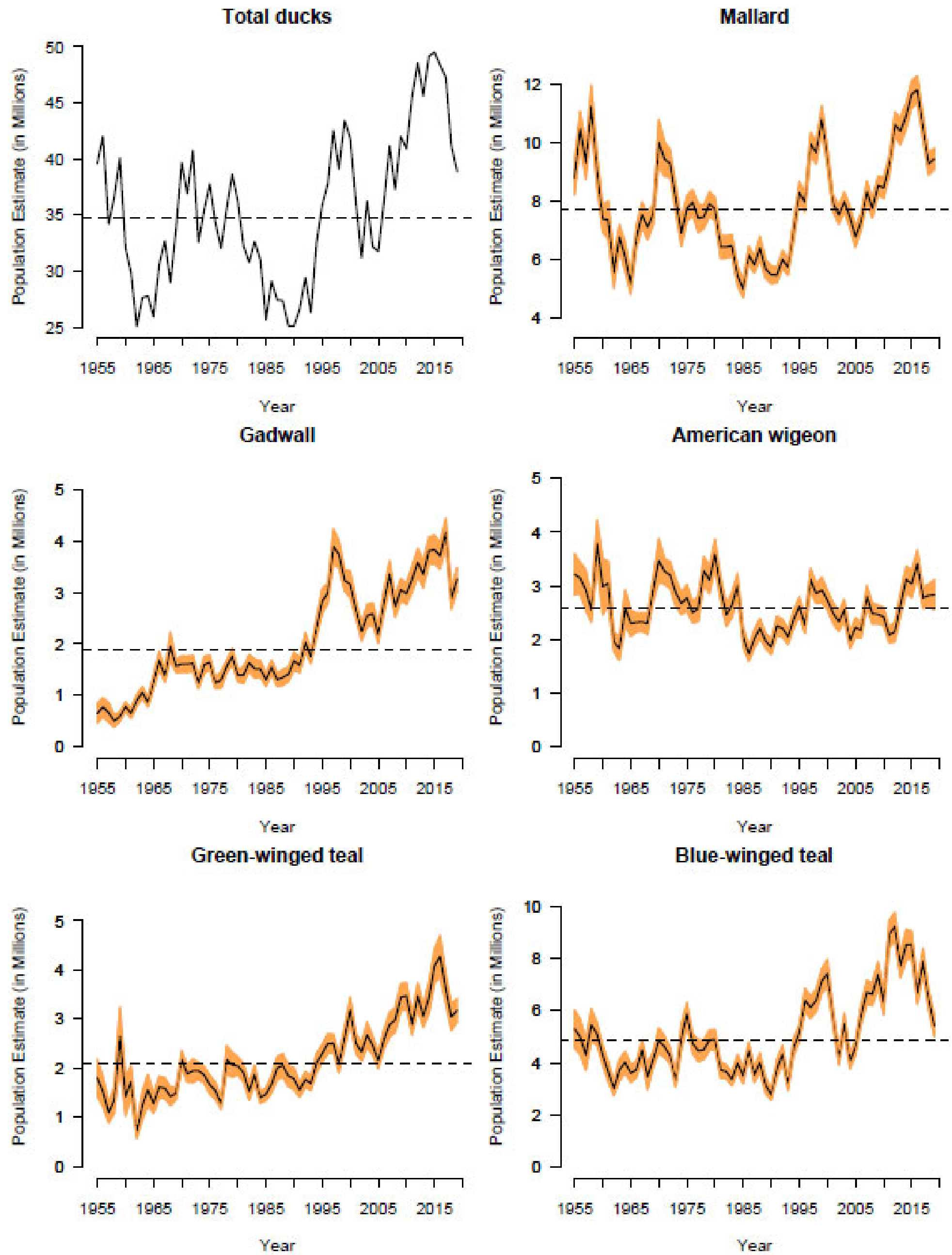

Figure 4. Breeding population estimates, 90% confidence intervals, and North American Waterfowl Management Plan population goals (dashed line; North American Waterfowl Management Plan Committee 2014) for selected species in the traditional survey area (strata 1–18, 20–50, 75–77).

Figure A5-1. Breeding populations estimates for species of dabbling ducks from the period 1955-2019. Original figures obtained from the Waterfowl Population Status, 2019 Report (USFWS 2019).

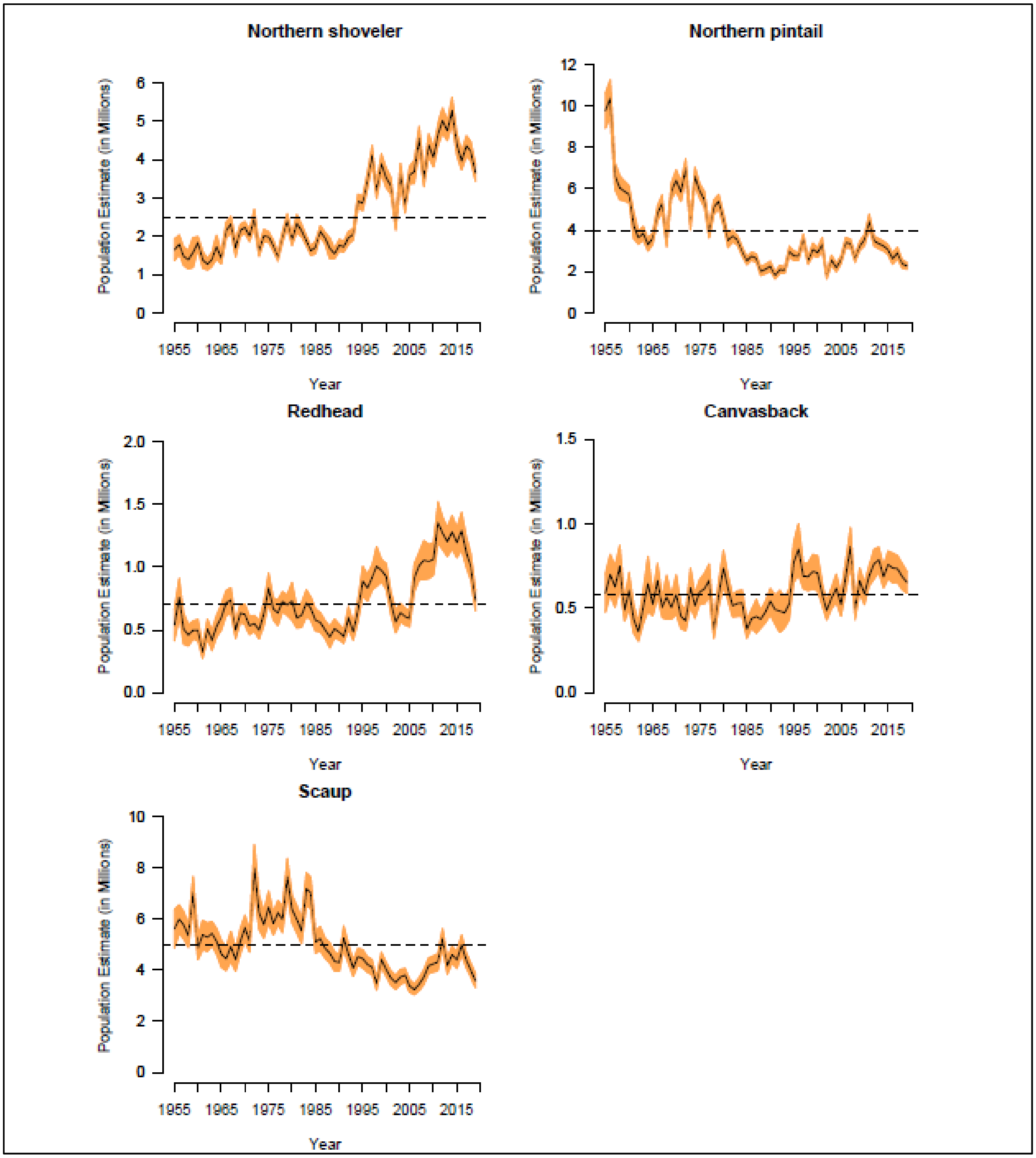

Figure A5-1 continued. Breeding populations estimates for species of dabbling ducks from the period 1955-2019. Original figures obtained from the Waterfowl Population Status, 2019 Report (USFWS 2019).

Table A5-1. Number of ducks observed during the midwinter waterfowl survey of the Mississippi flyway. Original table from Waterfowl Harvest and Population Survey Data (Fronczak 2019).

YEAR	MN[2]	WI	MI	IA	IL	IN	OH	MO	KY	AR	TN	LA	MS	AL	MFTOTAL
	Continued from previous page														
2001	30,056	50,147	78,321	9,087	98,580	15,812	101,200	85,701	113,679	604,240	481,138	5,818,758	180,932	114,882	7,782,533
2002	33,262	94,388	176,482	117,790	189,147	71,795	118,656	589,454	118,139	1,143,044	467,408	3,644,897	353,936	112,436	7,230,834
2003	27,691	165,093	101,379	119,353	159,660	10,274	71,265	300,014	43,827	553,397	344,658	3,129,665	209,799	88,522	5,324,597
2004	40,984	NS	185,287	34,095	216,950	9,904	85,324	641,185	35,163	298,149	256,290	3,852,088	188,831	86,963	5,931,213
2005	31,792	101,645	85,300	25,448	286,821	6,505	53,219	691,470	85,076	567,243	397,019	3,105,093	124,133	76,685	5,637,449
2006*	22,983	129,952	63,865	28,414	358,372	25,870	95,775	572,741	104,307	267,928	792,506	3,213,419	336,635	94,721	6,107,488
2007	12,426	79,658	155,827	161,241	177,152	19,448	102,179	530,455	65,648	485,502	376,254	4,737,227	144,977	68,895	7,116,889
2008	15,105	119,249	94,809	24,439	150,794	9,890	61,275	394,515	138,863	668,129	874,307	2,148,068	540,562	104,499	5,344,504
2009	28,238	69,340	105,262	19,820	127,225	23,655	94,758	367,441	101,679	910,353	518,139	2,011,575	546,561	117,771	5,041,817
2010[1]	25,985	77,473	157,401	21,787	148,917	14,533	48,561	147,468	107,027	3,013,623	850,266	3,434,357	934,140	65,152	9,046,690
2011	28,768	89,410	92,755	35,946	198,357	60,184	73,995	709,861	77,359	1,227,393	743,307	3,900,893	676,670	85,694	8,000,592
2012	30,465	119,522	NS	67,471	451,645	83,266	100,413	681,265	90,740	1,133,622	794,602	3,514,313	663,054	81,177	7,811,555
2013	14,940	80,825	NS	77,972	446,043	23,845	119,592	621,976	116,205	562,237	695,984	3,133,372	508,637	96,397	6,498,025
2014	16,091	45,423	101,858	68,830	150,906	30,062	79,816	396,079	108,410	1,017,246	717,302	4,054,418	1,281,276	81,264	8,148,981
2015	19,785	49,872	193,784	40,527	457,620	23,659	173,060	638,919	122,178	1,312,653	630,529	3,825,167	679,465	84,516	8,251,734
2016	24,730	127,902	209,411	61,314	796,235	36,014	114,061	753,452	52,777	1,065,338	862,482	2,485,532	537,911	60,684	7,187,843
2017	19,028	60,243	148,477	53,620	437,325	29,169	67,778	809,885	81,416	867,124	1,108,626	2,782,208	1,446,429	77,717	7,989,045
2018	9,856	64,125	105,241	45,498	358,629	42,248	104,427	492,877	100,258	1,241,709	787,519	3,499,143	1,150,947	82,063	8,084,540
2019		51,873	117,489	57,793	493,131	18,230	43,221	854,067	50,767	1,092,133	86,347	2,502,078	371,834	21,990	5,760,953
AVERAGES:															
55-60	15,867	42,433	138,717	91,567	976,433	556,067	101,283	368,100	156,983	1,328,217	390,117	2,271,283	159,567	89,867	6,686,500
61-70	11,670	35,020	49,410	138,830	400,670	61,510	94,560	322,950	57,510	1,289,020	404,080	4,934,590	244,480	106,130	8,150,430
71-80	25,890	20,640	42,540	114,190	411,960	37,380	64,780	312,380	42,330	931,690	395,680	3,798,880	400,600	96,030	6,694,970
81-90	26,428	35,632	47,265	56,290	222,754	26,340	62,768	195,680	32,286	1,005,389	374,195	3,077,005	262,650	79,514	5,504,197
91-00	16,902	49,389	110,141	28,234	195,650	32,347	126,204	388,455	49,833	891,267	445,882	3,506,333	222,893	91,048	6,143,563
01-10	26,852	98,549	120,393	56,147	191,362	20,769	83,221	432,044	91,341	851,161	535,799	3,509,515	356,051	93,053	6,456,401
11-20	20,458	76,577	138,431	56,552	421,099	38,520	97,374	662,042	88,901	1,057,717	714,078	3,299,680	812,914	74,611	7,525,919
Long-term	20,880	50,587	86,914	76,851	367,268	84,101	89,221	379,724	68,846	1,033,447	466,519	3,562,893	356,005	90,284	6,728,429

* - Incomplete survey. Estimates for the flyway and some states (IL, LA, 93; LA, MS, 97; MS, 06) are not comparable with other years. ** - NS = No survey DF 9/27/2019

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

However, these surveys do provide useful, general information on wintering waterfowl population levels.

The LMVJV has taken the lead on establishing population and habitat objectives for most birds in the MAV. For wintering waterfowl, these objectives include targets for American Black Duck (*Anas rubripes*) (53,000), American Wigeon (288,000), Canvasback (43,000), Gadwall (430,000), Scaup (1,354,000), Green-winged Teal (476,000), mallard (3,239,000), Northern Pintail (329,000), Northern Shoveler (89,000), Redhead (60,000), Ring-necked Duck (*Aythya collaris*) (277,000), Ruddy Duck (*Oxyura jamaicensis*) (55,000) and Wood Duck (1,622,000). Estimates for dabbling ducks in the Mississippi Flyway during 2018 were among the highest on record with ~6.8 million ducks (Fronczak 2019; Attachment 1). Recovery of waterfowl populations can be attributed to many conservation efforts including extensive funding to restore both breeding and wintering habitat. Expanding the USFWS National Wildlife Refuge system, creation of the duck stamp to fund wetland restoration, and large-scale participation with non-governmental organizations (NGOs), such as Ducks Unlimited and Delta Waterfowl, have and will continue to play a key role in sustaining waterfowl populations. Legislation, such as the Migratory Bird Treaty Act and North American Wetlands Conservation Act, have provided critical protection to waterfowl (Anderson et al. 2018). However, habitat loss, as well as factors such as climate change, continue to be significant threats to wildlife populations, including waterfowl (Mantyka-Pringle et al. 2012). Therefore, it remains critical to protect these resources for which waterfowl are dependent.

A5-2 METHODS

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

We calculated hectares (ha) of eight habitat types within the MAV for each of the MRL-SEIS II Work Items that flooded less than 18 inches during the period 1 November to 28 February according to the ENVIRO-DUCK hydrological model developed by USACE. Habitat categories were: 1) corn, 2) rice, 3) soybeans, 4) sorghum/milo, 5) floodplain forest, 6) grassland/seasonal herbaceous wetland (seasonal herbaceous [SHM] passively unmanaged), 7) open water/aquatic, and 8) shrub/scrub. Other land cover types in the MAV included developed lands (e.g., roads, residences, building sites, cities) and other agricultural lands that primarily include winter wheat or cotton. We did not analyze these latter land cover categories for DUD because they do not provide significant available waterfowl food sources (e.g., cotton, developed lands) or they do not require flooding for waterfowl use.

We determined food and energy values for the eight habitat types, by specified time period (month) from the DUD manual (Heitmeyer 2010). These energy values were related to a daily existence energy (DEE) for a mallard (1 mallard DEE = 452.44 kcal/day) and divided by the number of hectares of each flooded habitat to determine the potential DUDs/hectare/specified time period. The amount of food available on a unit area was determined from tables within the DUD manual (Heitmeyer 2010). For this waterfowl section, the methodology was further refined to include information on seed deterioration rates, seed availability/abundance, and invertebrate availability/abundance that was incorporated into energetic formulas (Heitmeyer 2010; Table A5-2). Although there are multiple species of waterfowl present in the project area, the mallard was selected to standardize all of the habitats found in the project area. Mallards are the most abundant duck species in the Mississippi Flyway. During migration periods, they use a variety of flooded forests and inundated agricultural fields, and a large amount of scientific research has been conducted on their habitat requirements and foraging ecology.

Waterfowl foraging habitat, regardless of food value, is only of use if available. Food availability is dependent on extent, duration, and depth of flooding. Ducks use relatively shallow water areas, 18 inches or less, for feeding. Using extensive hydrological data (Years 1969-2018), USACE estimated seasonal hectares flooded 18 inches or less for the wintering season using ENVIRO-DUCK model. The ENVIRO-DUCK model uses daily stage data and stage area curves to calculate the daily acres flooded during the 120-day wintering waterfowl season. The ENVIRO-DUCK program calculates daily acres for resting and feeding. The ENVIRO-DUCK program also calculates annual averages and the mean, minimum and maximum stage observed during the winter waterfowl season at all of the gage locations. The summary statistics were used to calculate the range of stages at each gage during the winter waterfowl season. A flood mapping tool (Flood Event Simulation Model, FESM is an ArcMap tool developed by USACE Vicksburg

Table A5-2. Estimated percent of maximum annual production of major food items available to wintering waterfowl in the MAV during November to February. Table obtained from Heitmeyer (2010; Table 14 of DUD manual).

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

District) was used to determine the areal extent of flooding for the range of stages at each gage. The land use data provided for the study area were specific to those hectares inundated and represent only potential available foraging habitat. By including the factors described above, the present methodology is more representative of winter waterfowl foraging habitat.

To meet the above requirements for calculating DUD, we determined habitat type and associated food resources within those habitats by acquiring spatial layers of land cover within the MAV. We acquired the spatial extent of work unit items within a geodatabase in ArcGIS from USACE, Mississippi Valley Division. We determined spatial extents by buffering Work Items by a half-mile buffer in ArcGIS. We used these spatial boundaries for each unit to determine land classification and features for subsequent analyses. We acquired the USDA Cropscape that determines annual crop production (USDA National Agricultural Statistics Service Cropland Data Layer. 2018). The Cropscape land cover provides classifications for crop production (e.g. corn, soybean, rice, cotton) as well as other general habitat types (e.g. deciduous forest, shrubland, woody or herbaceous wetlands). The primary crops within the project area for production year 2018 included: cotton, corn, soybean, sorghum/milo, rice, and agricultural browse. We created a new grouping of 10 broad habitat types to include: 1) Corn, 2) Cotton, 3) Forested, 4) Milo, 5) Open Water, 6) Other Crop, 7) Rice, 8) Seasonal Herbaceous (SHM)-Passively Unmanaged, 9) Shrub/Scrub, and 10) Soybeans (Attachment 1).

We also directly sampled 253 habitat plots associated with a habitat evaluation procedures (HEP) analysis, and this work included a determination of tree species composition. This ancillary work provided more biologically relevant data for forest adjacent to the Mississippi River levee system. We determined that overall, oak production only contributed to approximately 5 percent of the tree species that measure greater than 10 cm DBH. We further refined the forest classification according to canopy cover that was determined using the 2016 U.S. Forest Service Tree Canopy (Multi-resolution Land Characteristics Consortium 2018). We created three categories (5 percent, 10 percent, 20+ percent) according to percentage of canopy gaps within the forest cover layer. The forest canopy gap layer was used to inform the model based on Table 10 from the DUD manual (Heitmeyer 2010), which standardizes average herbaceous seed production from percentage of canopy gaps within forests. We grouped all cover types referenced as "grassland, prairie, or herbaceous" into one broader classification, SHM-Passively Unmanaged, for incorporation into the DUD manual (Attachment 1). One classification with reference to "shrubland" was categorized as Shrub-scrub (Attachment 1). We classified the remaining land cover groups, which contained "developed" land, "barren", or crops that would not contribute as energy for waterfowl as "Other Crop" and did not consider this within the DUD model (Attachment 1).

Heitmeyer (2010) designated six forest types according to forest composition/major food types, which include: Bottomland Hardwoods-Naturally Flooded (BLH-NF), BLH-Greentree Reservoirs (BLH-GTR), Cypress-Tupelo, Floodplain Forests, Riverfront Forest, and Dead Timber. Our HEP sampling plots did not result in any Cypress-Tupelo forest and the batture contained < 5 percent oak production. Heitmeyer (2010) described floodplain forest as the transition zone between riverfront forest and BLH that generally occurs within the 1-2 year flood frequency zone. Floodplain forest are dominated by elm (*Ulmus* spp.), ash (*Fraxinus* spp.), sweetgum (*Liquidambar styraciflua*), sugarberry/hackberry (*Celtis* spp.), and box elder (*Acer negundo*). Tree species within our HEP sample plots are consistent with the dominant species in floodplain forest. Riverfront forest is characterized by more early successional species, such as willow (*Salix* spp.) and silver maple (*Acer saccharinum*) and are associated more within the 1-year flood frequency. We sampled plots that were also consistent with that of riverfront forest, but these habitats were less frequent. Therefore, we grouped all forest for this analysis as Floodplain Forest rather than the more oak dominated BLH or Riverfront Forest. We were unable to determine if dead timber stands occurred within the Work Item footprints based on the spatial layers we obtained. We used our Shrub-scrub and Open water/Aquatic as direct inputs into Table 10 of the DUD manual (Heitmeyer 2010). We used our herbaceous layer for Heitmeyer's inputs of SHM-passively unmanaged, and did not include any calculations for SHM managed areas, as these sites are unlikely to be impacted. We did not attempt to determine areas classified as Persistent Emergent within the DUD manual, given the large spatial area of interest, but rather these sites that occur as a relatively minor component of the MAV landscape were lumped with SHM-unmanaged. We used the USDA Cropscape layer to define areas containing agricultural resources for waterfowl (i.e., corn, milo, rice, or soybean).

We compiled the flooded hectares of each habitat category according to Heitmeyer (2010) and incorporated them into the developed spreadsheet (see Supplemental Material; Attachment 1). To factor resource availability during the wintering waterfowl period (1 November- 28 February), we totaled each month together to use as the total DUD value, and also used this procedure for calculating DUD for mitigation lands to be reforested as BLH forest.

Mitigation values for DUDs were generated by incorporating previous data from the 1998 MRL-SEIS I (U. S. Army Corps of Engineers 1998) into the current DUD model's habitat categories (Heitmeyer 2010; Attachment 1). We calculated each habitat's contribution to DUD according to one hectare, and then calculated the contribution of that hectare across a 100-year period. Mitigation was based on restoring existing cropland to BLH forest consisting of at least 50 percent red oaks. The first five years after planting were given values according to SHM-passively unmanaged, as this period will primarily consist of herbaceous growth. The following 15 years (year 6-20) were not assigned any value toward DUDs, as this period will consist of dense woody vegetation that will likely be unsuitable as foraging habitat to wintering waterfowl.

Once trees reach the age of 20, oaks begin producing hard mast that contributes to energy resources and were given the category of "BLH-NF, 5 percent tree gaps and canopy openings, average density, small trees" for 15 years (year 21-35). The next 15 years (year 36-50) were assigned "BLH-NF, 5 percent tree gaps and canopy openings, average density, medium trees" and the final 50 years (year 51-100) as "BLH-NF, 5 percent tree gaps and canopy openings, average density, large trees". These DUD values were totaled for the 100-year period to determine the level of mitigation credit needed to replace flooded habitats used by wintering waterfowl.

The creation of borrow pits will result in small gains of suitable foraging habitat to waterfowl. Fringe wetlands consisting of shallow water areas are assumed to occur on the edges of borrow pits. The 1998 SEIS I (U. S. Army Corps of Engineers 1998) assumed this to be 7 percent of the total borrow pit area, with an average between SHM-passively unmanaged and soybean used to generate DUD's for fringe wetlands surrounding deeper water habitats. The remaining 93 percent of habitat created will be open water-aquatic habitat that has a very small contribution to DUD's in the energy value of aquatic invertebrates.

A5-3 RESULTS

Out of the total 2,949.4 hectares (7,288.2 acres) encompassing the footprints of the Work Items analyzed in the SEIS II, Alternative 3 (Avoid and Minimize) would experience a loss of 211.4 hectares (522.4 acres) of flooded (<18 in) habitats for waterfowl, while Alternative 2 (Traditional Construction) would experience a loss of 258.6 hectares (639.0 acres) (Table A5-3a-b). The U.S. Army Corps of Engineers, Vicksburg District will experience the greatest habitat losses (152.2 ha, 545,676 DUD; Table A5-4a), followed by Memphis District (50.8 ha, 99,029 DUD; Table A5-4a) and New Orleans District (8.4 ha, 18,240 DUD; Table A5-4a) under Alternative 3 (Avoid and Minimize). Vicksburg District will also experience the greatest habitat losses under Alternative 2 (Traditional Construction) (158.0 ha, 550,068 DUD; Table A5-4b), followed by Memphis District (63.4 ha, 141,330 DUD; Table A5-4b) and New Orleans District (37.2 ha, 92,411 DUD; Table A5-4b). In addition to the Vicksburg District having the greatest loss of flooded hectares, it also has significantly more habitat consisting of SHM-passively unmanaged that has a higher DUD contribution compared to other habitat types (Table A5-4a). Floodplain forest and soybeans will also be significantly reduced from creation of borrow pits within the Memphis and Vicksburg Districts (Table A5-4a). The same general trend for habitat loss occurs with the traditional alternative; however, even more flooded forest will be lost with the traditional alternative, especially in the Memphis and New Orleans District (Table A5-4b).

For both Alternatives 2 and 3, the greatest loss of wintering waterfowl habitat will occur in Louisiana as approximately 75 percent of the lost acreage within MRL Work Items are within the State (Table A5-5; Attachment 1). Loss of habitat to wintering waterfowl in Arkansas (20 and 32 ha) and Missouri (21 and 23 ha) will be moderately low while Illinois, Kentucky, Mississippi, and Tennessee will have negligible losses of < 2.5 ha and 10 ha combined according to Alternative 3 and 2, respectively (Table A5-5; Attachment 1).

Table A5-3a. Summary of the total number of duck-use-days during the winter waterfowl period (Nov-Feb) in the Memphis, Vicksburg, and New Orleans Districts and area of flooded foraging habitat impacted by Work Item alterations within different work types for Alternative 3.

District	**MRL Work Type**	**Total DUD (Nov-Feb)**	**Acres Impacted**	**Hectares Impacted**
	Riverside Borrow Area	23,218	48.3	19.6
	Levee Enlargement	72,893	72.9	29.5
	Relief Wells	2,918	4.4	1.8
Memphis-Total		99,029	125.6	50.8
Vicksburg				
	Riverside Borrow Area	326,776	243.7	98.6
	Landside Haul Roads	2,767	2.0	0.8
	Riverside Haul Roads	180,718	111.5	45.1
	Levee Enlargement	31,432	15.0	6.1
	Seepage Berm	3,984	3.8	1.5
Vicksburg-Total		545,676	376.0	152.2
New Orleans				
	Landside Borrow Area	12,747	17.9	7.3
	Floodwall Replacement	55	0.0	0.0
	Levee Enlargement	5,444	2.8	1.1
New Orleans-Total		18,246	20.7	8.4
Grand Total		**662,951**	**522.3**	**211.4**

Table A5-3b. Summary of the total number of duck-use-days during the winter waterfowl period (Nov-Feb) in the Memphis, Vicksburg, and New Orleans Districts and area of flooded foraging habitat impacted by Work Item alterations within different work types for Alternative 2.

District	**MRL Work Type**	**Total DUD (Nov-Feb)**	**Acres Impacted**	**Hectares Impacted**
	Riverside Borrow Area	64,968	79.3	32.1
	Levee Enlargement	73,184	73.0	29.5
	Relief Wells	3,177	4.4	1.8
Memphis-Total		141,330	156.7	63.4
Vicksburg				
	Riverside Borrow Area	323,028	249.2	100.9
	Landside Haul Roads	128	0.1	0.0
	Riverside Haul Roads	191,484	122.4	49.5
	Levee Enlargement	31,434	15.0	6.1
	Seepage Berm	3995	3.8	1.5
Vicksburg-Total		550,068	390.4	158.0
New Orleans				
	Landside Borrow Area	17,536	25.4	10.3
	Riverside Borrow Area	71,209	64.3	26.0
	Floodwall Replacement	728	0.6	0.2
	Levee Enlargement	2,938	1.7	0.7
New Orleans-Total		92,411	91.9	37.2
Grand Total		783,809	639.0	258.6

Table 5-4a. Summary of flooded habitats for wintering waterfowl within MRL-SEIS II Work Items and the number of DUD lost during the period from November-February within each District for the Alternative 3.

District	Habitat Type	Total DUD (Nov-Feb)	Acres Impacted	Hectares Impacted
Vicksburg	Corn	139	0.1	0.1
	Floodplain Forest (5% canopy openings)	29,772	45.6	18.4
	Floodplain Forest (10% canopy openings)	10,260	13.1	5.3
	Floodplain Forest (20+% canopy openings)	139,276	133.4	54.0
	Open Water-Aquatic	4	0.0	0.0
	Rice	254	0.4	0.2
	SHM Passively Unmanaged	335,047	122.4	49.5
	Shrub/Scrub	12,873	11.0	4.5
	Soybeans	18,052	49.9	20.2
Vicksburg Total		545,676	376.0	152.2
Memphis	Corn	2,905	2.6	1.0
	Floodplain Forest (5% canopy openings)	3,519	5.4	2.2
	Floodplain Forest (10% canopy openings)	3,250	4.1	1.7
	Floodplain Forest (20+% canopy openings)	56,826	54.4	22.0
	Rice	5	0.0	0.0
	SHM Passively Unmanaged	10,771	3.9	1.6
	Shrub/Scrub	2,642	2.3	0.9
	Soybeans	19,111	52.9	21.4
Memphis Total		99,029	125.6	50.8
New Orleans	Corn	87	0.1	0.0
	Floodplain Forest (5% canopy openings)	8,445	12.9	5.2
	Floodplain Forest (10% canopy openings)	3,169	4.0	1.6
	Floodplain Forest (20+% canopy openings)	1,498	1.4	0.6
	SHM Passively Unmanaged	4,395	1.6	0.6
	Shrub/Scrub	616	0.5	0.2
	Soybeans	36	0.1	0.0
New Orleans Total		18,246	20.7	8.4
Grand Total		662,951	522.3	211.4

Table A5-4b. Summary of flooded habitats for wintering waterfowl within MRL-SEIS II Work Items and the number of DUD lost during the period from November-February within each District for Alternative 2.

District	Habitat Type	Total DUD (Nov-Feb)	Acres Impacted	Hectares Impacted
Vicksburg				
	Corn	139	0.1	0.1
	Floodplain Forest (5% canopy openings)	59,676	91.3	37.0
	Floodplain Forest (10% canopy openings)	31367	40.0	16.2
	Floodplain Forest (20+% canopy openings)	106,457	101.9	41.2
	Open Water-Aquatic	8	0.1	0.0
	Rice	254	0.4	0.2
	SHM Passively Unmanaged	330,585	120.8	48.9
	Shrub/Scrub	12,564	10.8	4.4
	Soybeans	9,019	24.9	10.1
Vicksburg Total		550,068	390.4	158.0
Memphis				
	Corn	2,097	1.9	0.8
	Floodplain Forest (5% canopy openings)	22,176	33.9	13.7
	Floodplain Forest (10% canopy openings)	10,486	13.4	5.4
	Floodplain Forest (20+% canopy openings)	85,101	81.5	33.0
	Open Water-Aquatic	19	0.2	0.1
	Rice	5	0.0	0.0
	SHM Passively Unmanaged	11,859	4.3	1.8
	Shrub/Scrub	2,642	2.3	0.9
	Soybeans	6,945	19.2	7.8
Memphis Total		141,330	156.7	63.4
New Orleans				
	Corn	122	0.1	0.0
	Floodplain Forest (5% canopy openings)	24,573	37.6	15.2
	Floodplain Forest (10% canopy openings)	15,415	19.7	8.0
	Floodplain Forest (20+% canopy openings)	25,623	24.5	9.9
	Open Water-Aquatic	0	0.0	0.0
	SHM Passively Unmanaged	26,498	9.7	3.9
	Shrub/Scrub	126	0.1	0.0
	Soybeans	54	0.1	0.1
New Orleans Total		92,411	91.9	37.2
Grand Total		783,809	639.0	258.6

Table A5-5. Summary of flooded habitats for wintering waterfowl within MRL-SEIS II Work Items and the number of DUD lost during the period from November-February within each District and state for Alternatives 3 and 2.

		Alt.. 3 (Avoid/Minimize)			Alt. 2 (Traditional Const.)		
District	**State**	**Total DUD (Nov-Feb)**	**Acres Impacted**	**Hectares Impacted**	**Total DUD (Nov-Feb)**	**Acres Impacted**	**Hectares Impacted**
Vicksburg	Louisiana	542,614	371.7	150.4	546,522	386.1	156.2
	Mississippi	3,062	4.3	1.8	3,546	4.3	1.8
Vicksburg Total			376.0	152.2	550,068	390.4	158.0
Memphis	Arkansas	57,001	76.3	30.9	67,150	79.6	32.2
	Illinois	0	0.0	0.0	6,250	5.9	2.4
	Kentucky	19	0.0	0.0	876	0.3	0.1
	Mississippi	0	0.0	0.0	10,152	13.1	5.3
	Missouri	41,512	48.1	19.5	56,476	56.6	22.9
	Tennessee	497	1.2	0.5	426	1.2	0.5
Memphis Total			125.6	50.8	141,330	156.7	63.4
New Orleans	Louisiana	18,246	20.7	8.4	92,411	91.9	37.2
Grand Total		**662,951**	**522.3**	**211.4**	**783,809**	**639.0**	**258.6**

A total of 578,550 DUD per hectares of BLH forest consisting of at least 50 percent red oaks over the 100-year period would be generated from successful restoration (Table A5-6). Therefore, the number of hectares of BLH forest needed to mitigate losses to wintering waterfowl habitat would be 90.2 hectares (223 acres), 15.71 (39 acres), and 3.15 hectares (8 acres) in the Vicksburg, Memphis, and New Orleans Districts, respectively, for Alternative 3 (Table A5-7a). The number of hectares of BLH forest needed to mitigate losses to wintering waterfowl habitat under the Alternative 2 would be 86.6 hectares (214.0 acres), 21.8 hectares (53.8 acres), and 13.0 hectares (32.0 acres) in the Vicksburg, Memphis, and New Orleans Districts, respectively, (Table A5-7b). Approximately 93 percent of the Work Items (2,738 of 2,949 hectares) were not considered suitable habitat for foraging by waterfowl because they lacked flooded conditions or were flooded more than 18 inches in depth for Alternative 3 (Avoid and Minimize).

Table 5-6. Mitigation in terms of number of duck-use-days across the winter period for waterfowl (mallard) for one hectare of land replanted with average density of oaks in a bottomland hardwood forest over the course of 100 years.

Habitat Type[a]	**Project Life (Years)**	**Nov-Feb Totals**	**Years**	**Total DUD**
SHM-Passively Unmanaged	1-5	6,763.17	5	33,816
Densely populated early-successional forest[b]	6-20	0.00	15	0
BLH-NF, 5% tree gaps and canopy openings, average density, small trees	21-35	6,130.52	15	91,958
BLH-NF, 5% tree gaps and canopy openings, average density, medium trees	36-50	6,602.63	15	99,039
BLH-NF, 5% tree gaps and canopy openings, average density, large trees	51-100	7,074.73	50	353,737
Total number of DUD for mitigation across 100 years for 1 hectare			100	**578,550**

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

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

Table A5-7a. Calculation of DUD gains and losses over a 100-year project life according to the creation or loss of flooded habitats used by wintering waterfowl within MRL Work Items for Alternative 3 (Avoid and Minimize). Mitigation values from creation of BLH are used for determining needed acreage to mitigate for losses within the MAV.

			Hectares		Annual DUD		DUD over 100 Year Project Life		Impacted DUD across Project Life
District	Habitat Type	DUD/ha	Gain	Loss	Gain	Loss	Gain	Loss	
Vicksburg	Borrow Pit Open Water[a]	232	45.3		10,519		1,051,932		
	Fringe Wetlands[b]	3,828	3.4		13,061		1,306,133		
	Corn	2,767		0.1		139		13,851	
	Floodplain *Forest* (5% canopy openings)	1,614		18.4		29,772		2,977,182	
	Floodplain Forest (10% canopy openings)	1,937		5.3		10,260		1,026,021	
	Floodplain Forest (20+% canopy openings)	2,581		54.0		139,276		13,927,597	
	Open Water-Aquatic	232		0.0		4		417	
	Rice	1,518		0.2		254		25,401	
	SHM Passively Unmanaged	6,763		49.5		335,047		33,504,681	
	Shrub/Scrub	2,881		4.5		12,873		1,287,296	
	Soybeans	893		20.2		18,052		1,805,160	
Vicksburg Total			48.7	152.2	23,581	545,676	2,358,064	54,567,605	**-52,209,541**
Hectares (acres) needed for mitigation[c]									**90.2 hectares (223.0 acres)**
Memphis	Borrow Pit Open Water[a]	232	15.6		3,628		362,802		
	Fringe Wetlands[b]	3,828	1.2		4,505		450,474		
	Corn	2,767		1.0		2,905		290,504	
	Floodplain Forest (5% canopy openings)	1,614		2.2		3,519		351,867	
	Floodplain Forest (10% canopy openings)	1,937		1.7		3,250		325,004	
	Floodplain Forest (20+% canopy openings)	2,581		22.0		56,826		5,682,557	
	Rice	1,518		0.0		5		525	
	SHM Passively Unmanaged	6,763		1.6		10,771		1,077,125	
	Shrub/Scrub	2,881		0.9		2,642		264,183	
	Soybeans	893		21.4		19,111		1,911,097	
Memphis Total			16.8	50.8	8,133	99,029	813,276	9,902,861	**-9,089,585**
Hectares (acres) needed for mitigation[c]									**15.7 hectares (38.8 acres)**
New Orleans	Borrow Pit Open Water[a]	232	0.0		6		647		
	Fringe Wetlands[b]	3,828	0.0		8		804		

Corn	2,767		0.0		87		8,721	
Floodplain Forest (5% canopy openings)	1,614		5.2		8,445		844,485	
Floodplain Forest (10% canopy openings)	1,937		1.6		3,169		316,890	
Floodplain Forest (20+% canopy openings)	2,581		0.6		1,498		149,833	
SHM Passively Unmanaged	6,763		0.6		4,395		439,462	
Shrub/Scrub	2,881		0.2		616		61,617	
Soybeans	893		0.0		36		3,599	
New Orleans Total		0.0	8.4	15	18,246	1,451	1,824,607	**-1,823,156**
Hectares (acres) needed for mitigation[c]								**3.2 hectares (7.8 acres)**
Grand Total		65.6	211.4	31,728	662,951	3,172,791	66,295,073	**-63,122,282**
Hectares (acres) needed for mitigation[c]								**109.1 hectares (269.6 acres)**

[a] Open water-aquatic habitats are calculated for borrow pits created in cropland (soybean or corn) or SHM passively unmanaged lands. Construction of borrow pits with shallow edges will allow for 7 percent fringe wetlands and remaining 93 percent as open water-aquatic.

[b] Duck-use-days calculated for fringe-wetland around borrow pits created in croplands by averaging DUD values for soybeans and SHM passively unmanaged lands.

[c] Mitigation calculated as the total gain in number of DUD from creation of borrow pits minus the loss of DUD from loss of flooded waterfowl foraging habitat from levee construction activities divided by the number of DUD generated from replanting bottomland hardwoods containing at least 50 percent red oaks (Table 6).

Table A5-7b. Calculation of DUD gains and losses over a 100-year project life according to the creation or loss of flooded habitats used by wintering waterfowl within MRL Work Items for the traditional alternative. Mitigation values from creation of BLH are used for determining needed acreage to mitigate for losses within the MAV.

			Hectares		Annual DUD		DUD over 100 Year Project Life		Impacted DUD across Project Life
District	**Habitat Type**	**DUD/ha**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	
Vicksburg	Borrow Pit Open Water[a]	232	93.8		21,761.6		2,176,160		
	Fringe Wetlands[b]	3,828	7.1		27,178.8		2,717,880		
	Corn	2,767		0.1		139		13,900	
	Floodplain Forest (5% canopy openings)	1,614		37		59,676		5,967,600	
	Floodplain Forest (10% canopy openings)	1,937		16.2		31367		3,136,700	
	Floodplain Forest (20+% canopy openings)	2,581		41.2		106,457		10,645,700	
	Open Water-Aquatic	232		0		8		800	
	Rice	1,518		0.2		254		25,400	
	SHM Passively Unmanaged	6,763		48.9		330,585		33,058,500	
	Shrub/Scrub	2,881		4.4		12,564		1,256,400	
	Soybeans	893		10.1		9,019		901,900	
Vicksburg Total			100.9	158.1	48,940.4	550,069	4,894,040	55,006,900	-50,112,860
Hectares (acres) needed for mitigation[c]									**86.6 hectares (214.0 acres)**
Memphis	Borrow Pit Open Water[a]	232	29.9		6,936.8		693,680		
	Fringe Wetlands[b]	3,828	2.2		8,421.6		842,160		
	Corn	2,767		0.8		2,097		209,700	
	Floodplain Forest (5% canopy openings)	1,614		13.7		22,176		2,217,600	
	Floodplain Forest (10% canopy openings)	1,937		5.4		10,486		1,048,600	
	Floodplain Forest (20+% canopy openings)	2,581		33		85,101		8,510,100	
	Open Water-Aquatic	232		0.1		19		1,900	
	Rice	1,518		0		5		500	
	SHM Passively Unmanaged	6,763		1.8		11,859		1,185,900	
	Shrub/Scrub	2,881		0.9		2,642		264,200	
	Soybeans	893		7.8		6,945		694,500	
Memphis Total			32.1	63.5	15,358.4	141,330	1,535,840	14,133,000	-12,597,160
Hectares (acres) needed for mitigation[c]									**21.8 hectares (53.8 acres)**

New Orleans	Borrow Pit Open Water[a]	232	33.8		7,841.6		784,160		
	Fringe Wetlands[b]	3,828	2.5		9,570		957,000		
	Corn	2,767		0		122		12,200	
	Floodplain Forest (5% canopy openings)	1,614		15.2		24,573		2,457,300	
	Floodplain Forest (10% canopy openings)	1,937		8		15,415		1,541,500	
	Floodplain Forest (20+% canopy openings)	2,581		9.9		25,623		2,562,300	
	Open Water-Aquatic	232		0		0		0	
	Rice	1,518		0		0		0	
	SHM Passively Unmanaged	6,763		3.9		26,498		2,649,800	
	Shrub/Scrub	2,881		0		126		12,600	
	Soybeans	893		0.1		54		5,400	
New Orleans Total			36.3	37.1	17,411.6	92,411	1,741,160	9,241,100	-7,499,940
Hectares (acres) needed for mitigation[c]									**13.0 hectares (32.0 acres)**
Grand Total			169.3	258.7	81,710.4	783,810	8,171,040	78,381,000	-70,209,960
Hectares (acres) needed for mitigation[c]									**121.4 hectares (299.9 acres)**

[a] Open water-aquatic habitats are calculated for borrow pits created in cropland (soybean or corn) or SHM passively unmanaged lands. Construction of borrow pits with shallow edges will allow for 7 percent fringe wetlands and remaining 93 percent as open water-aquatic.

[b] Duck-use-days calculated for fringe-wetland around borrow pits created in croplands by averaging DUD values for soybeans and SHM passively unmanaged lands.

[c] Mitigation calculated as the total gain in number of DUD from creation of borrow pits minus the loss of DUD from loss of flooded waterfowl foraging habitat from levee construction activities divided by the number of DUD generated from replanting bottomland hardwoods containing at least 50 percent red oaks (Table 6).

A5-4 DISCUSSION

Levee maintenance and construction Work Items along the mainline Mississippi River levee, primarily associated with the construction of new borrow pits to acquire fill material for levee enlargement, will result in significant loss of waterfowl habitat acreage. However, the potential for enhancing BLH forests consisting of at least 50 percent red oaks that are frequently flooded less than 18 inches in depth could more than offset this loss of habitat. Almost all of the forested habitats that currently occurs in the batture, and much of the landside forest, lack oak species that contribute to higher food resources for waterfowl. In the short term, removing the current forest community will have negative effects on both wintering waterfowl using these areas as loafing sites, as well as to breeding and wintering habitat for a variety of other avian species. However, long-term impacts to wintering waterfowl will greatly be improved by incorporating mitigation recommendations from Table A5-6 of this report, as well as following guidelines from the LMVJV MAV Waterfowl Stepdown (Lower Mississippi Valley Joint Venture 2015).

A significant portion (93 percent) of the Work Items were not considered as suitable foraging habitat for wintering waterfowl because water levels suitable for foraging were not present or the habitat did not provide energetic resources. The two primary types of work that do impact waterfowl habitat are levee enlargement and creation of borrow pits. Habitats associated with levee enlargements are directly adjacent to existing levees, and are not likely to flood except in years of extremely high water. Creation of borrow pits is much more likely to result in the loss of habitat and DUD's; however, the avoidance and minimization measures proposed to be undertaken by the USACE, which include selecting either lower quality habitats (i.e., croplands) or landside areas not likely to flood, should significantly reduce the areas that may be lost to wintering waterfowl.

Subsequent paragraphs from the USFWS outline recommended mitigation measures in the event that current habitat is altered as a result of work associated with the Work Items in the SEIS II. Incorporating these guidelines into mitigation will aid in offsetting any habitat loss that was unavoidable with Alternative 3, the preferred alternative. Restoring a total of 109.1 hectares (270 acres) of croplands outside of current Work Items to BLH forest consisting of at least 50 percent red oak species known to benefit waterfowl would offset the loss of DUDs from project construction. Planting a variety of red oak species producing smaller-sized acorns and tolerable of periodic flooding, such as Pin Oak (*Quercus palustris*), Water Oak (*Q. nigra*), Willow Oak, (*Q. phellos*), Cherrybark Oak (*Q. falcate*), and Nutall's Oak (*Q. texana*) will be beneficial to wintering waterfowl in the MAV. As described in Section 5.0 of the SEIS II, the 1,447 acres of wetland mitigation would offset all waterfowl habitat losses.

Selecting sites for restoration in the Memphis District that account for potential influence of climate change should be considered. The U.S. has recently been experiencing warming temperatures and in some years a reduction in snow cover that allows waterfowl to remain further north without the need to migrate to more southerly latitudes. The Weather Severity Indices model predicts increased residency times for dabbling ducks during autumn and winter at northern and mid-latitudes (Schummer et al. 2017). Increased residency times at these locations will result in food resources becoming depleted faster with the need to maximize wetland conservation in these areas.

The USFWS also provides the following recommendations:

"Project features should be located and designed to avoid impacts to wetlands and non-wetland forested habitat. Should unavoidable impacts occur, those impacts should be minimized to the greatest extent possible. Any remaining unavoidable impacts must then be mitigated. Mitigation planning, including site selection and design, should be closely coordinated with the Service and other interested natural resource agencies. Full, in-kind compensation should be quantified and should be provided for unavoidable net adverse impacts on forested areas, wetlands, marsh, and associated submerged aquatic vegetation. Mitigation measures that would provide habitat for at-risk species in the project area should be included in any mitigation plan and project features; the Service can assist in development of such measures.

Mitigation measures should be constructed concurrently with the features that they are mitigating (i.e., mitigation should be completed no later than 18 months after levee construction has begun). If mitigation is provided via an in-lieu fee program or mitigation bank, completed mitigation would be achieved when credits were purchased from either source. If mitigation is not implemented concurrent with levee construction, the amount of mitigation needed should be reassessed and adjusted to offset temporal habitat losses. The Service may elect to assess impacts utilizing recently completed local/regional habitat models; while the Service recognizes that USACE must use models they have certified, those models may not fully capture all aspects of impacts or local/regional mitigation needs. Currently, USACE has mitigated most of the anticipated impacts determined for the previous SEIS I with some mitigation occurring prior to the impacts, however, there still remains some mitigation required. The Service recommends that completion of the previous SEIS I required mitigation be made a priority.

For the last SEIS I, the Service recommended that mitigation areas contain a high proportion (i.e., 75%) of red oaks to fully offset lost wintering waterfowl habitat (i.e., duck use days). While the Service maintains its concern about the loss of feeding habitat for wintering waterfowl, the Service no longer recommends that high proportion of red oaks but recommends an adequate mixture of varying hard mast species suited to the mitigation site based on soils and hydrology. For projects within Louisiana the Service recommends a minimum of 50 percent hard mast species."

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A5-6 ATTACHMENT 1

ATTACHMENT 1 - WATERFOWL

Breeding waterfowl population estimate for dabbling ducks calculated from traditional breeding season surveys by the U.S. Fish and Wildlife Service for the period 1955-2019. Original table obtained from: U.S. Fish and Wildlife Service. 2019. Waterfowl population status, 2019. U.S. Department of the Interior, Washington, D.C. USA.

Table B.3. Breeding population estimates and standard errors (in thousands) for 10 species of ducks from the traditional survey area (strata 1–18, 20–50, 75–77), 1955–2019.

	Mallard		Gadwall		American wigeon		Green-winged teal		Blue-winged teal	
Year	$\hat{N}$	$\widehat{SE}$	$\hat{N}$	$\widehat{SE}$	$\hat{N}$	$\widehat{SE}$	$\hat{N}$	$\widehat{SE}$	$\hat{N}$	$\widehat{SE}$
1955	8,777.3	457.1	651.5	149.5	3,216.8	297.8	1,807.2	291.5	5,305.2	567.6
1956	10,452.7	461.8	772.6	142.4	3,145.0	227.8	1,525.3	236.2	4,997.6	527.6
1957	9,296.9	443.5	666.8	148.2	2,919.8	291.5	1,102.9	161.2	4,299.5	467.3
1958	11,234.2	555.6	502.0	89.6	2,551.7	177.9	1,347.4	212.2	5,456.6	483.7
1959	9,024.3	466.6	590.0	72.7	3,787.7	339.2	2,653.4	459.3	5,099.3	332.7
1960	7,371.7	354.1	784.1	68.4	2,987.6	407.0	1,426.9	311.0	4,293.0	294.3
1961	7,330.0	510.5	654.8	77.5	3,048.3	319.9	1,729.3	251.5	3,655.3	298.7
1962	5,535.9	426.9	905.1	87.0	1,958.7	145.4	722.9	117.6	3,011.1	209.8
1963	6,748.8	326.8	1,055.3	89.5	1,830.8	169.9	1,242.3	226.9	3,723.6	323.0
1964	6,063.9	385.3	873.4	73.7	2,589.6	259.7	1,561.3	244.7	4,020.6	320.4
1965	5,131.7	274.8	1,260.3	114.8	2,301.1	189.4	1,282.0	151.0	3,594.5	270.4
1966	6,731.9	311.4	1,680.4	132.4	2,318.4	139.2	1,617.3	173.6	3,733.2	233.6
1967	7,509.5	338.2	1,384.6	97.8	2,325.5	136.2	1,593.7	165.7	4,491.5	305.7
1968	7,089.2	340.8	1,949.0	213.9	2,298.6	156.1	1,430.9	146.6	3,462.5	389.1
1969	7,531.6	280.2	1,573.4	100.2	2,941.4	168.6	1,491.0	103.5	4,138.6	239.5
1970	9,985.9	617.2	1,608.1	123.5	3,469.9	318.5	2,182.5	137.7	4,861.8	372.3
1971	9,416.4	459.5	1,605.6	123.0	3,272.9	186.2	1,889.3	132.9	4,610.2	322.8
1972	9,265.5	363.9	1,622.9	120.1	3,200.1	194.1	1,948.2	185.8	4,278.5	230.5
1973	8,079.2	377.5	1,245.6	90.3	2,877.9	197.4	1,949.2	131.9	3,332.5	220.3
1974	6,880.2	351.8	1,592.4	128.2	2,672.0	159.3	1,864.5	131.2	4,976.2	394.6
1975	7,726.9	344.1	1,643.9	109.0	2,778.3	192.0	1,664.8	148.1	5,885.4	337.4
1976	7,933.6	337.4	1,244.8	85.7	2,505.2	152.7	1,547.5	134.0	4,744.7	294.5
1977	7,397.1	381.8	1,299.0	126.4	2,575.1	185.9	1,285.8	87.9	4,462.8	328.4
1978	7,425.0	307.0	1,558.0	92.2	3,282.4	208.0	2,174.2	219.1	4,498.6	293.3
1979	7,883.4	327.0	1,757.9	121.0	3,106.5	198.2	2,071.7	198.5	4,875.9	297.6
1980	7,706.5	307.2	1,392.9	98.8	3,595.5	213.2	2,049.9	140.7	4,895.1	295.6
1981	6,409.7	308.4	1,395.4	120.0	2,946.0	173.0	1,910.5	141.7	3,720.6	242.1
1982	6,408.5	302.2	1,633.8	126.2	2,458.7	167.3	1,535.7	140.2	3,657.6	203.7
1983	6,456.0	286.9	1,519.2	144.3	2,636.2	181.4	1,875.0	148.0	3,366.5	197.2
1984	5,415.3	258.4	1,515.0	125.0	3,002.2	174.2	1,408.2	91.5	3,979.3	267.6
1985	4,960.9	234.7	1,303.0	98.2	2,050.7	143.7	1,475.4	100.3	3,502.4	246.3
1986	6,124.2	241.6	1,547.1	107.5	1,736.5	109.9	1,674.9	136.1	4,478.8	237.1
1987	5,789.8	217.9	1,305.6	97.1	2,012.5	134.3	2,006.2	180.4	3,528.7	220.2
1988	6,369.3	310.3	1,349.9	121.1	2,211.1	139.1	2,060.8	188.3	4,011.1	290.4
1989	5,645.4	244.1	1,414.6	106.6	1,972.9	106.0	1,841.7	166.4	3,125.3	229.8
1990	5,452.4	238.6	1,672.1	135.8	1,860.1	108.3	1,789.5	172.7	2,776.4	178.7
1991	5,444.6	205.6	1,583.7	111.8	2,254.0	139.5	1,557.8	111.3	3,763.7	270.8
1992	5,976.1	241.0	2,032.8	143.4	2,208.4	131.9	1,773.1	123.7	4,333.1	263.2
1993	5,708.3	208.9	1,755.2	107.9	2,053.0	109.3	1,694.5	112.7	3,192.9	205.6
1994	6,980.1	282.8	2,318.3	145.2	2,382.2	130.3	2,108.4	152.2	4,616.2	259.2
1995	8,269.4	287.5	2,835.7	187.5	2,614.5	136.3	2,300.6	140.3	5,140.0	253.3
1996	7,941.3	262.9	2,984.0	152.5	2,271.7	125.4	2,499.5	153.4	6,407.4	353.9
1997	9,939.7	308.5	3,897.2	264.9	3,117.6	161.6	2,506.6	142.5	6,124.3	330.7
1998	9,640.4	301.6	3,742.2	205.6	2,857.7	145.3	2,087.3	138.9	6,398.8	332.3
1999	10,805.7	344.5	3,235.5	163.8	2,920.1	185.5	2,631.0	174.6	7,149.5	364.5
2000	9,470.2	290.2	3,158.4	200.7	2,733.1	138.8	3,193.5	200.1	7,431.4	425.0
2001	7,904.0	226.9	2,679.2	136.1	2,493.5	149.6	2,508.7	156.4	5,757.0	288.8
2002	7,503.7	246.5	2,235.4	135.4	2,334.4	137.9	2,333.5	143.8	4,206.5	227.9