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# *Amphibian Habitat Assessment at the Paducah Gaseous Diffusion Plant and the West Kentucky State Wildlife Management Area*

## January 15, 2016


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## EXECUTIVE SUMMARY

This report describes a habitat assessment for amphibians at the West Kentucky Wildlife Management Area (WKWMA) in McCracken County, Kentucky. During August and September 2015, 118 wetland habitats in 11 tracts were assessed. Wetland density varied considerably among tracts, with Tract 1 (n = 18), Tract 2 (n = 25), and Tract 7A (n = 18) having the highest densities. Wetlands also varied in hydro-period or inundation level. We considered 60 wetlands to be permanent meaning they contained water 75% - 100% of the growing season. We documented 34 regularly or seasonally inundated (i.e., 25% - 75% of growing season inundated) wetlands located within forests and 14 regularly or seasonally inundated wetlands within grassland habitat. We considered 9 wetlands to be artificial or recently created. Unique wetland types, including a Tupelo swamp, an open-water button bush swamp, and an extensive beaver pond complex are also found on WKWMA. We documented 10 amphibian species within or adjacent to these wetlands during our habitat assessments; based on these findings and known distributions of amphibians in western Kentucky, we expect WKWMA to have high amphibian diversity. In late August 2015, high school students from Marshall High School aided in habitat analysis of artificial wetlands. With the help of high school students, we plan to revisit many of the wetlands in spring 2016 and relate habitat characteristics to patterns of amphibian distribution and abundance. Overall, this research aids in the establishment of a monitoring program for a key indicator group (i.e., amphibians) that is currently a major data gap in ecological investigations at PGDP and WKWMA.

# INTRODUCTION

Halbrook et al. (2007) recently evaluated the ecological monitoring program and provided guidelines for future monitoring at Paducah Gaseous Diffusion Plant (PGDP) and the West Kentucky Wildlife Management Area (WKWMA). Halbrook et al. (2007) found that most ecological research on the PGDP and WKWMA focused on terrestrial endotherms (e.g., mammals and birds but see DeGarady & Halbrook (2003 & 2006)). Amphibians represent a significant data gap in ecological investigations at PGDP and WKWMA. Amphibians are critical components of both aquatic and terrestrial ecosystems; they often have remarkable densities (Gibbons et al. 2006), they feed at a variety of trophic levels (Beard et al. 2002), and, because of their significant biomass, they represent important nutrient vectors linking aquatic and terrestrial ecosystems (Regester et al. 2006). Many amphibian species can be particularly susceptible to anthropogenic impacts and some have been touted as indictors of environmental integrity (Vitt et al. 1990; Houlahan and Findlay 2003; Price et al. 2008). Thus, information gathered on local amphibian populations can provide information on the integrity of ecosystems

The PGDP and WKWMA are located in the Mississippi Embayment, a northern extension of the Southeastern Coastal Plain region known for its rich amphibian diversity. In fact, several of Kentucky's amphibians are primarily restricted to the Mississippi Embayment, including 14 species that are being monitored or given special management consideration in Kentucky. Thirty-four amphibian species potentially occur at PGDP and WKWMA; these species have vastly different reproductive modes and habitat preferences. For example, some species only breed in streams, whereas other species can only successfully recruit in seasonally inundated wetlands. Given the deactivation and decommissioning of PGDP, and the requirement of Department of Energy (DOE) to assess ecological damages and mitigate for these damages, it becomes imperative to have an understanding of the available amphibian habitats.

Primary objectives of this project include: **(1) Identification and assessment of aquatic and adjacent terrestrial habitats potentially important for amphibians at PGDP and WKWMA, (2) Conduct preliminary surveys for amphibians during habitat assessment** and **(3) Provide educational opportunities for local high school students to participate in ecological monitoring and assessment.** The report is concluded with a discussion of the significance of the wetland habitats at WKWMA and the general direction for surveying these wetlands for amphibians.

# METHODS

## Study Site

The WKWMA is a 6,500 acre (2630 ha) area owned and leased by the Kentucky Department of Fish and Wildlife Resources (KDFWR) in McCracken County, Kentucky (Figure 1). The management area is in the Mississippi Embayment physiographic province, bordering the Ohio River to the north.

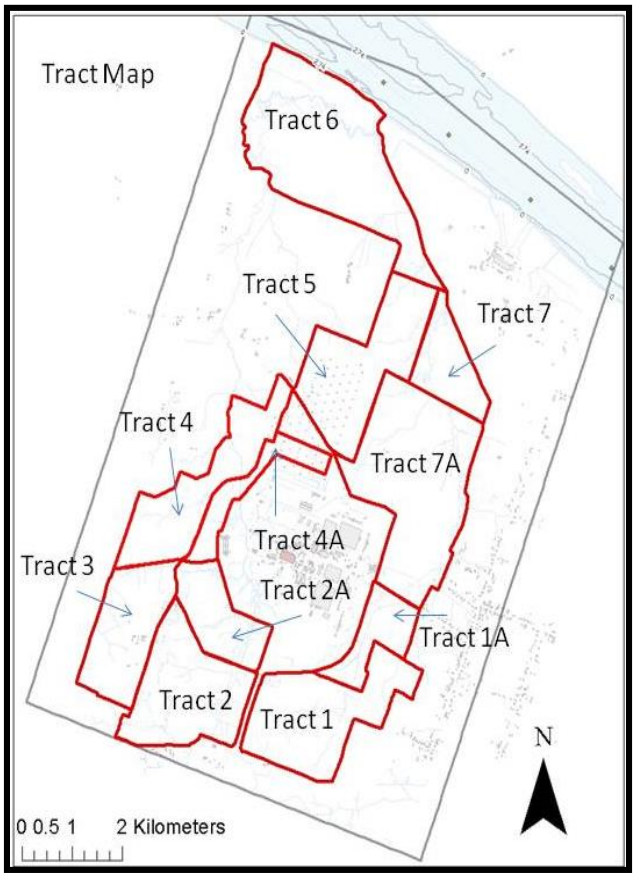


**Figure 1.** Map of tracts in the West Kentucky Wildlife Management Area (WKWMA) in McCracken County, Kentucky. Amphibian habitat was assessed in each of the tracts (red) on the WKWMA.

Each wetland was designated using its location in each tract within the WKWMA. The tracts in the WKWMA consist of two types, those owned by the KDFWR and tracts leased to KDFWR by DOE (Designated with an "A") or Tennessee Valley Authority (TVA). The land-cover of the WKWMA consists of both open habitat (grasslands, pasture, food plots, row crop agriculture, etc.) and forests, including both upland mixed-hardwood forests and lowland swamps. Two creeks, Little Bayou Creek and Big Bayou

Creek, run through the site and empty into the Ohio River. The WKWMA surrounds the PGDP, a fenced, uranium enriching facility that has been in place since 1952. Land-use within the fenced area of PGDP consists of open habitats, mixed hardwood forests, manicured lawn, industrial facilities and associated human structures including large areas of impervious surfaces (roads, parking lots, etc.). Habitat for amphibians within the fenced area of the PDGP was not assessed.

### Habitat Assessment Methods

Amphibian habitats were assessed and classified using remotely sensed datasets, site maps, local expertise and field observations. We used a geographic information system (GIS; ArcGIS (10.0 ERSI, Redlands, CA)) and wetland layers, based on a wetland assessment of WKWMA and PDGP by the US Army Corps of Engineers (US ACE; 1994), to locate potential amphibian breeding habitat within the WKWMA. We define "wetland" broadly and consider a variety of water bodies as potential amphibian habitat, regardless of hydroperiod (i.e., permanent or semi-permanent, regularly or seasonally inundated, etc.) or other habitat components. After identifying wetlands within each WKWMA tract, we generated geographic coordinates (NAD 1983; UTM ZONE 16) of their exact location.

During August and September 2015, we conducted numerous site visits to WKWMA, totaling 26 person days of assessment (Table 1). Geographic coordinates (see above) were used to navigate to wetlands to conduct field assessments. After locating, confirming, and photographing each wetland, we recorded characteristics of the local habitat. We defined local habitat as the hydrologic features, general vegetation communities and other habitat components within 5 meters of the aquatic-terrestrial interface. Specifically, we determined wetland physical structure by recording the percent of each wetland area in a) open water, b) floating vegetation, c) emergent vegetation, d) shrubs, e) trees, and f) mud flats/dried, unvegetated wetland basin. We also categorized the amount of submergent plants, stems or twigs within each wetland basin as these represent important structures for amphibian egg deposition (Shulse et al.,

2010; 2012). In addition, we categorized the amount of coarse woody debris within and adjacent to the wetland basin. Coarse woody debris often serves as refuge for adult and recently metamorphosed amphibians (Whiles and Grubaugh 1996).

We estimated the duration of inundation of each site, noting that our projections were temporally limited and may not represent the long-term hydroperiod of these wetlands. Hydroperiod is a critical determinant of survival to metamorphosis and breeding population size in amphibians; most importantly, duration of inundation influences amphibian predators' (i.e., fish, newts (*Notophthalamus viridescens*), some macroinvertebrate species) presence or absence. We considered permanently inundated wetlands to be those that continually maintained surface water. We considered wetlands to be semi- to regularly inundated if these sites likely contained water for 25%-75% of the growing season; we suspected that numerous dry wetlands that we assessed fit this inundation classification based on observed field conditions (saturated soils, high water marks, etc.). We also considered some wetlands to be seasonally inundated, which only hold water for ≤ 25% of the growing season. In addition to estimating duration of inundation, we attempted to determine the most likely source of water (surface water (over bank), groundwater (seep) or precipitation). Finally, we noted any alteration to natural hydrologic regime, including ditches, tiles, storm-water inputs, road beds and/or filling or grading activities in or near the wetland.


**Figure 2**. A spherical densiometer was used to estimate canopy cover above each wetland.

Percent canopy cover was recorded for each wetland by using a spherical densiometer (Forestry Suppliers, Jackson, MS, USA, see Vora 1988) during full-leaf out at the four cardinal directions around each wetland (Figure 2). Numerous studies have documented that canopy cover is an important determinant of amphibian diversity patterns in wetlands (Baldwin et al. 2006; Skelly et al. 2005; Earl et al. 2011). In addition, we recorded the presence of several invasive plant species as secondary plant compounds from invasive plants has been shown to affect development and increase mortality of larval amphibians (See Maerz et al. 2005; Watling et al. 2011). Finally, we documented and recorded any amphibians and/or amphibian predators seen during the wetland assessment. See Supplementary Material (Appendix I) for datasheet used in assessment.

After field surveys were conducted, each wetland was further examined using a GIS. First, we calculated the area of each wetland in hectares (ha). Secondly, we estimated the quality of non-breeding or terrestrial habitat for amphibians. Non-breeding habitats, such as forests, often greatly influence the species composition at any given breeding site (See Marsh and Trenham 2001; Cosentino et al. 2011). A buffer of 290 meters was projected around each wetland based on the "amphibian-relevant buffer" (see Semlitsch and Bodie 2013). Within each buffered area we estimated the percent coverage (to the nearest 5%) of several land cover type categories. We considered mature forest, other wetlands, and forested wetlands to be of high quality non-breeding habitat for amphibians. Young forests, agricultural fields, and other low impact features (old fields, lightly managed parkland, etc.) were considered moderately high quality non-breeding amphibian habitat. We considered two-lane roads, residential and lawns, utility right-of-ways as moderately low quality habitat. Low quality habitat included commercial or industrial land, paved areas (roads, parking lots) or row crop fields. The area of each land use category was then estimated as a percentage, with all four types totaling 100 percent. In addition, we determined the distances of each wetland to important features like nearby wetlands and roadways.

**Table 1.** Visits to WKWMA occurred over the summer of 2015 from July to September. All surveys equated to 26 person days on site.

| Dates | Total Days | Total Person Days |
|---|---|---|
| 8/3/2015 | 1 | 2 |
| 8/9/2015 – 8/10/2015 | 2 | 8 |
| 8/24/2015 – 8/25/2015 | 2 | 4 |
| 8/30/2015 – 8/31/2015 | 2 | 4 |
| 9/6/2015 – 9/7/2015 | 2 | 4 |
| 9/12/2015 – 9/13/2015 | 2 | 4 |
| Total Survey Effort | 11 | 26 |

# RESULTS

## Habitat Assessment

### TRACT 1

Tract 1 covers approximately 286 ha in the southeast corner of WKWMA (Figure 1). This tract is the most extensively farmed tract in the WKWMA with row crop fields covering roughly 40% of the tract. Scattered woodlots and grasslands constitute the other major land cover classes. Using GIS and US ACE wetland layers, we initially focused on 21 wetlands in Tract 1. Three wetlands were excluded from field assessments. Eighteen wetlands were assessed in Tract 1.

We assessed Tract 1 wetlands, totaling 2.7 ha, on 30 August 2015 (Figure 3). Physical structure of the wetlands in Tract 1 varied considerably, although 12 wetlands contained some floating or emergent vegetation and/or partially inundated shrubs that may provide oviposition sites for amphibians. Coarse woody debris varied considerably among sites, although coarse woody debris was dense at six wetlands (1-7, 1-8, 1-9, 1-11, 1-13, 1-18). We considered 12 wetlands to be permanently inundated and we documented fish and/or invertebrate predators in four of these wetlands. The remaining wetlands were classified as regularly

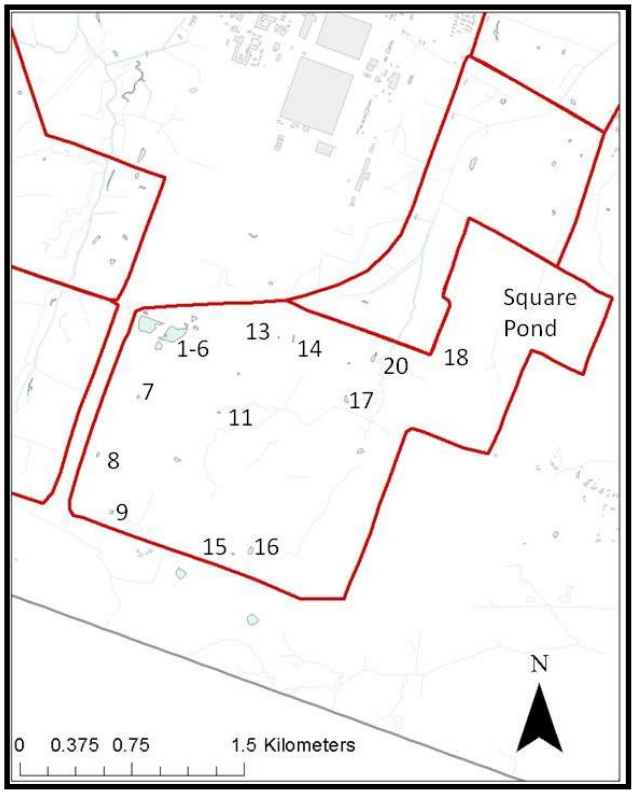


**Figure 3.** Location of assessed wetlands in Tract 1 of the WKWMA.

or seasonally inundated; fish were not detected in these wetlands. Tract 1 also contained Square Pond, a created wetland regularly inundated for amphibians and migratory shorebirds. Seven wetlands had canopy cover estimates of > 85% whereas six wetlands had no canopy cover. Invasive plant species observed in or adjacent to wetlands included Japanese Stilt Grass (*Microstegium vimineum*), cattail species (*Typha* ssp), Japanese Honeysuckle (*Lonicera japonica*), non-native *Lespedeza ssp.*, Multiflora Rose (*Rosa multiflora*), and Parrotfeather (*Myriophyllum aquaticum*). We detected the presence of five amphibian species in Tract 1, including green frogs (*Lithobates clamitans*), Bullfrog (*Lithobates catesbeianus*), southern leopard frog (*Lithobates sphenocephalus*), Cope's gray treefrogs (*Hyla chrysoscelis*) and northern cricket frogs (*Acris crepitans*).

Given the high densities of wetlands in Tract 1, sampled wetlands were, on average, only 153 m from the next nearest wetland. Assessed wetlands were 135 m from the nearest roads, although several wetlands (1-1, 1-2, 1-13, 1-14, 1-20, "Square Pond") were < 20 m from the nearest road. The majority of land-use within 290 m of each wetland (i.e., "amphibian-relevant buffer") was considered high or moderately high quality non-breeding amphibian habitat; only wetlands 1-15 and 1-16 had > 30% low quality non-breeding amphibian habitat within the amphibian relevant buffer. See Supplementary Material (Appendix 2) for additional information on Tract 1.

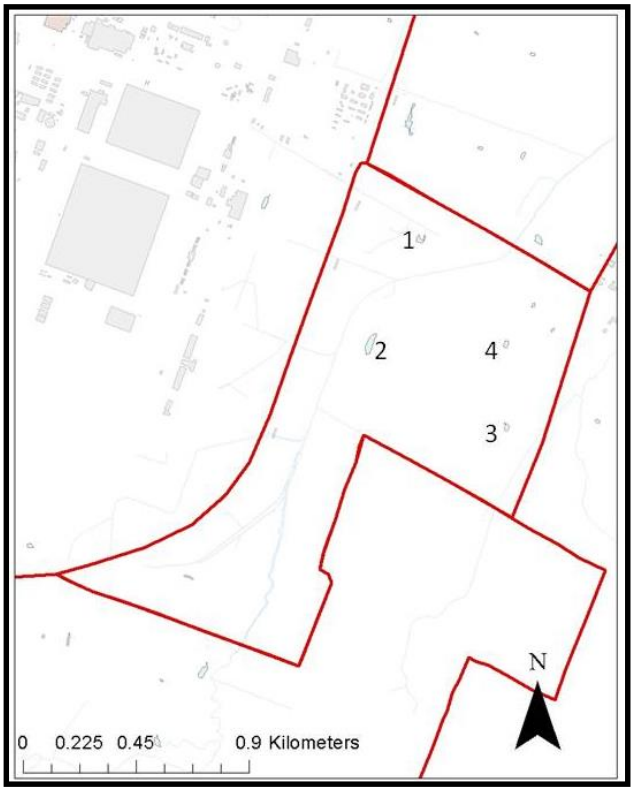


**Figure 4.** Location of assessed wetlands in Tract 1A of the WKWMA.

TRACT 1A

Tract 1A is approximately 100 hectares and is situated in the southeastern portion of the WKWMA (Figure 1). Land cover in Tract 1A is dominated by grassland and scattered hardwood forests. Tract 1A is leased to KDFWR by DOE.

We initially focused on eight wetlands in Tract 1A, although four sites were dropped due to inaccessibility or our inability to locate sites during field assessments. We examined four wetlands, totaling 0.33 ha, on 31 August and 6 September 2015 (Figure 4). Two wetlands were dry or almost dry during our assessment and thus we considered these sites to be regularly or seasonally inundated. Wetlands 1A-2 and 1A-3 appeared to be permanently inundated, with extensive amounts of open water or floating vegetation,

**Figure 5.** Wetland 1A-2 was a permanently inundated wetland with low canopy cover. Fish were documented in this wetland.

respectively (Figure 5). Site 1A-2 was the only wetland in Tract 1A where we detected fish. Coarse woody debris was present within or near all wetlands, and four sites contained some floating or emergent vegetation and/or partially inundated shrubs that may provide amphibian oviposition sites. Five wetlands had canopy cover estimates of > 60%; 1A-2 had average cover of 10%. Invasive plant species observed in

or adjacent to wetlands included Japanese Stilt Grass, Japanese Honeysuckle, non-native *Lespedeza ssp.*, and Multiflora Rose. We detected 5 amphibian species in Tract 1A including green frogs, northern cricket frogs, upland chorus frogs (*Pseudacris feriarum*), Fowler's toads (*Anaxyrus fowleri*), and mole salamanders (*Ambystoma talpodieum*).

Most wetlands in Tract 1A were isolated from other wetlands; on average sampled wetlands were 264 m from the nearest wetland. Assessed wetlands were 83 m from the nearest roads. Similar to Tract 1, the majority of land-use within the amphibian-relevant buffer was considered high or moderately high quality non-breeding amphibian habitat. Site 1A – 10 had approximately 50% low quality non-breeding amphibian habitat within the amphibian relevant buffer. See Supplementary Material (Appendix 2) for additional information on Tract 1A.

TRACT 2

Located in the southern half of WKWMA, Tract 2 is 265 ha. Land cover is primarily forest, row crop agriculture fields, and several extensive wetland complexes, including the Box Factory ponds, Robinson Pond and a recently created, semi-permanent wetland known as Rice Springs (Figure 6). Using GIS and US ACE wetland layers, we determined that at least 28 wetlands were available for assessment. We focused our efforts on 25 of those.

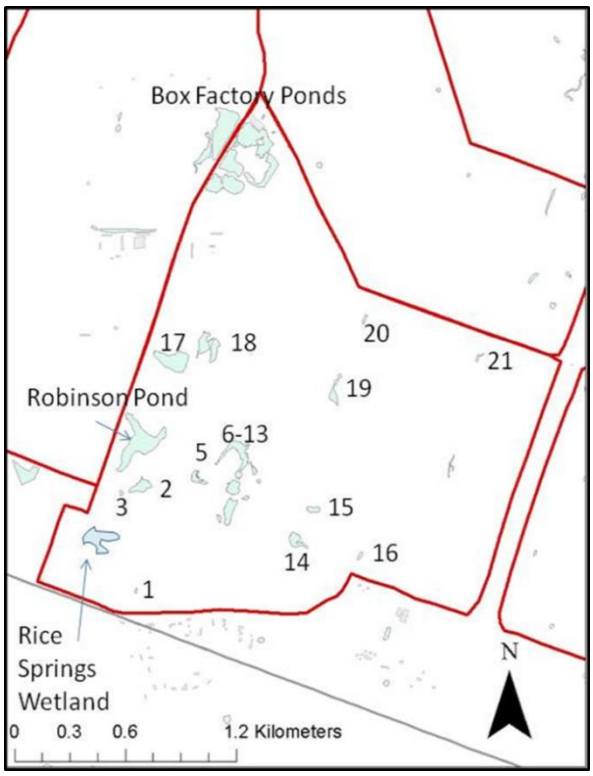


**Figure 6.** Location of assessed wetlands in Tract 2 of the WKWMA.

The 25 wetlands assessed in Tract 2 totaled 8.79 ha. Assessments were conducted on 9 August, 25 August and 30 August, 2015. Nineteen of the 26 wetlands had extensive amounts of open water and were likely permanently inundated. Rice Springs, a wetland

created and managed for amphibians, is also found in Tract 2. We detected fish and other amphibian predators (turtles, water snakes) in many of these wetlands. Nonetheless, five amphibian species (green frogs, bullfrogs, southern leopard frogs, cricket frogs, and mole salamanders) were found during the assessments. Oviposition sites and coarse woody debris was relatively low at the majority of the wetlands likely due to high use of these sites by fishermen. The majority of sites (i.e., 17) had < 25% canopy closure. We documented Japanese Stilt Grass, Japanese Honeysuckle, non-native *Lespedeza ssp.*, cattail *ssp*., Parrotfeather, Multiflora Rose and Common Reed (*Phragmites australis*) in or adjacent to assessed wetlands.

Many of the wetlands in Tract 2 were highly clustered, averaging only 71 m to their nearest neighbor. Assessed wetlands ranged from 7 m to 276 m to the nearest road, and despite high use by recreationists, the average distance to the nearest road was approximately 95 m. Habitat within 290 m of the assessed wetlands was considered high to moderately high quality for most wetlands. See Supplementary Material (Appendix 2) for additional information on Tract 2.

**Figure 8.** Wetland 5 in Tract 2 of the WKWMA. Regularly or seasonally inundated wetlands with canopy cover were common within Tract 2 and throughout WKWMA. These wetlands offer breeding habitat for a variety of amphibian species, especially mole salamanders.

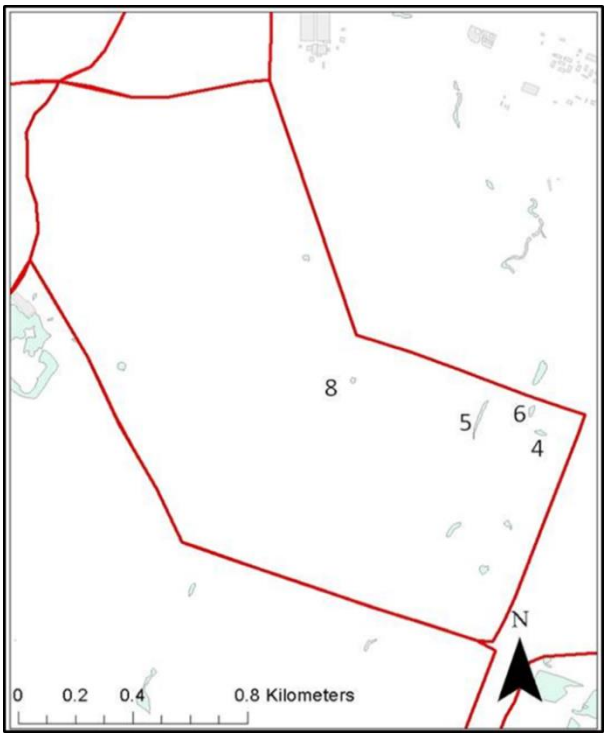


**Figure 7.** Location of assessed wetlands in Tract 2A of the WKWMA.

## TRACT 2A

Tract 2A is approximately 135 ha and located just southwest of the PGDP facility (Figure 1). Dominant land cover included utility right-of-ways, grassland, and upland hardwood forests. Tract 2A is leased to KDFWR by DOE. Using GIS and US ACE wetland layers, ten wetlands were initially selected for assessment. Due to inaccessibility of six wetlands, efforts were focused on four wetlands in Tract 2A.

Four wetlands, totaling 0.15 ha, were assessed on 12 September 2015 (Figure 8). The assessed wetlands were surrounded by forest, consequently our estimate of canopy cover exceeded 75% in all cases. At the time of assessment, three of the wetlands had some open water or floating vegetation, and all wetlands had moderate to high coarse woody debris within or adjacent to wetland. Amphibian predators were not detected during our assessment, yet only one amphibian species (northern cricket frog) was documented. We observed Japanese Stilt grass, Japanese Honeysuckle, and Multiflora Rose within or adjacent to wetlands. We considered one of the wetlands as permanently inundated and the other three wetlands to be regularly or seasonally inundated.

Given the close proximity to PDGP, the assessed wetlands in 2A contained ≥ 30% moderately low quality or low habitat within 290 m of each wetland. Low quality habitat included commercial or industrial land and paved areas (roads, parking lots) in PDGP. Assessed wetlands were, on average, 176 m from the nearest wetland and approximately 86 m from the nearest road. See Supplementary Material (Appendix 2) for additional information on Tract 2A.

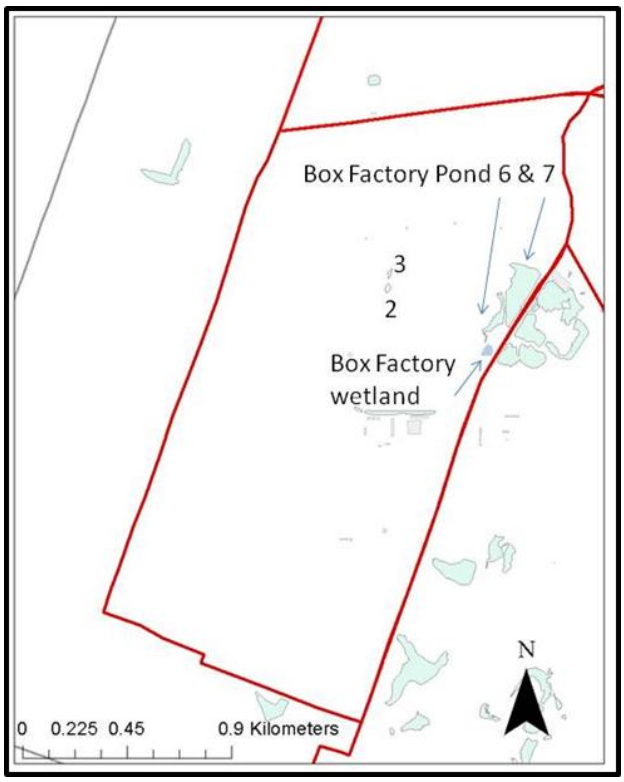


**Figure 9.** Location of assessed wetlands in Tract 3 of the WKWMA.

TRACT 3

Tract 3 is located in the southwestern corner of WKWMA and covers approximately 200 ha (Figure 1). Land cover in Tract 3 is dominated by forest. Using GIS and US ACE wetland layers, eight total wetlands were selected for assessment. Due to inaccessibility of three wetlands, only five wetlands were assessed in Tract 3 (Figure 9).

Tract 3 wetlands, totaling 1.72 ha, were assessed on 8 August and 7 September 2015. Two wetlands (3-2 and 3-3) were considered regularly and seasonally inundated, respectively, and did not contain open water on the assessment date. The remaining wetlands in Tract 3 were considered permanent; three of these wetlands were part of the Box Factory complex and contained extensive amounts of emergent vegetation. In general, submergent vegetation and other oviposition sites were somewhat limited at most wetlands in Tract 3. The amount of coarse woody debris was considered "moderate" at sites 3-2, 3-5 and the Box Factory wetland. Invasive plants observed included observed Japanese Stilt grass, Japanese Honeysuckle, *Typha ssp.*, non-native *Lespedeza ssp.*, and Multiflora Rose within or adjacent to wetlands. We documented the presence of green frogs, southern leopard frogs, bullfrogs and cricket frogs (Figure 10).

**Figure 10.** Northern cricket frogs were commonly detected in the WKWMA wetlands.

Assessed wetlands in Tract 3 were located in close proximity to other wetlands and to roads. Average distance between wetlands was 52 m and distance to the nearest road was 46 m. We considered the majority of land-use within the amphibian buffer to be high or moderately high quality. See Supplementary material (Appendix 2) for additional information on Tract 3.

TRACT 4

Tract 4 covers approximately 227 ha on the west side of the WKWMA (Figure 1). The tract has relatively low amount of forest cover; dominant land cover consists of grassland and row crop agricultural fields. Using the GIS and US ACE wetlands layers, we selected 12 wetlands for assessment. During field assessments, we located three additional wetlands (Figure 11). In total, we assessed 15 wetlands in Tract 4.

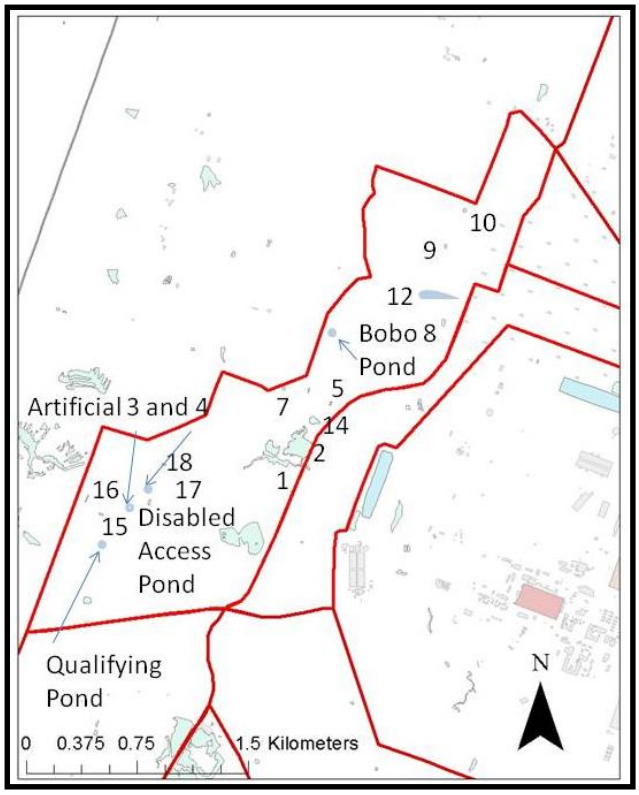


**Figure 11.** Location of assessed wetlands in Tract 4 of the WKWMA.

Wetlands were assessed on 10 August, 8 September and 12 September 2015 (Figure 9). The total area of these wetlands was 5.42 ha. Physical structure of the wetlands in Tract 4 varied considerably as the assessed wetlands ranged from recently created (i.e., man-made or artificial) wetlands to natural, ephemeral wetlands to fishing ponds. In fact, five wetlands in Tract 4 were recently created, including: "Artificial 3", "Artificial 4", Qualifying Pond, wetland 4-12, and Bobo Pond.

Nine wetlands contained some floating or emergent vegetation and/or partially inundated shrubs that provide oviposition sites for amphibians. We considered 12 wetlands to be permanently inundated and we documented fish and/or invertebrate predators in 11 of these wetlands. The remaining wetlands were classified as regularly or seasonally inundated; fish were not detected in these wetlands. Six wetlands (mostly regularly or seasonally inundated) had canopy cover estimates of > 85% whereas six wetlands had no canopy cover. Invasive plant species observed in or adjacent to wetlands included Japanese Stilt Grass, Cattail *ssp*, Japanese Honeysuckle, Multiflora Rose, and Common Reed. We detected the presence of six

amphibian species in Tract 4, including green frogs, bullfrog, southern leopard frog, Cope's gray treefrogs, mole salamander, and northern cricket frogs.

Tract 4 wetlands averaged 125 m from the nearest wetland and 84 m from the nearest roads. However, several wetlands (4-1, 4-2, 4-7, 4-14, 4-16 and "Disabled Access Pond") were < 20 m from the nearest road. The majority of land-use within 290 m of each wetland was considered high or moderately high quality non-breeding amphibian habitat; only "Disabled Access Pond" had > 30% low quality non-breeding amphibian habitat within the amphibian relevant buffer. See Supplementary Material (Appendix 2) for additional information on Tract 4.

On August 31 2015, Marshall County High School Students (Tina Marshall's Environmental Science Class) assisted with habitat and preliminary amphibian surveys at Qualifying Pond, Bobo Pond and other wetlands. During these sessions, students were taught about amphibian habitats and given a brief overview of our sampling techniques. During spring 2016, we anticipate revisiting these wetlands, sampling these sites for amphibians, and relating habitat to patterns of species distribution.

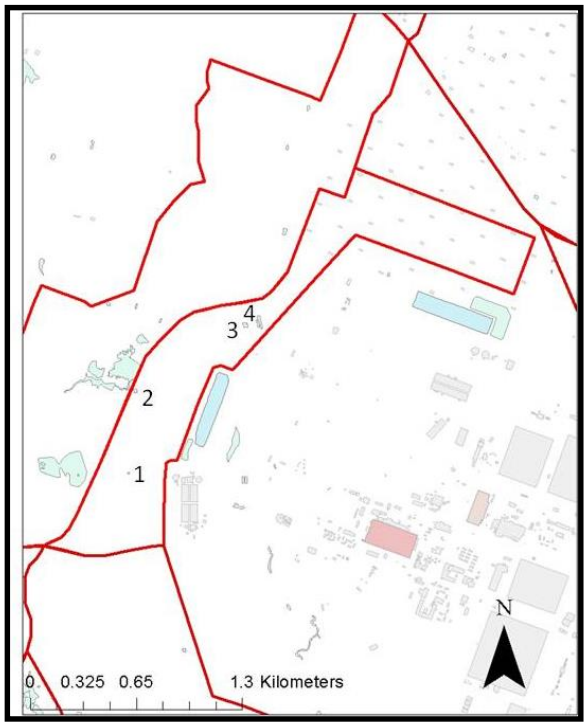


**Figure 12.** Location of assessed wetlands in Tract 4A of the WKWMA.

TRACT 4A**

Bordering the PGDP facility to the northwest (Figure 1), Tract 4A is composed of upland forest and grassland. The total area of Tract 4A is 87 ha. Tract 4A is also leased to the WKWMA. Using GIS and available wetland layers, we located four wetlands in Tract 4A (Figure 12); all four wetlands, totaling 0.9 ha, were assessed on 12 September 2015.

Three of the wetlands were considered permanently inundated; 4A-3 was considered regularly inundated and was dominated by emergent, wetland vegetation that may provide oviposition sites for amphibians. Coarse woody debris was present within or adjacent to all assessed wetlands. We did not document fish in any of the wetlands. Three wetlands had canopy cover estimates of > 85% while 4A-4 had 43% cover. Invasive plant species observed in or adjacent to wetlands included Japanese Stilt Grass, Multiflora Rose, and Japanese Honeysuckle. We detected 7 amphibian species in Tract 4A, including green frogs, southern leopard frogs, Bullfrog, Cope's gray treefrogs, upland chorus frog, northern cricket frogs and mole salamanders.

Wetlands were, on average, 98.75 m from the nearest wetland and 102.89 m from the nearest roads. No wetlands were found within < 20 m from the nearest road. All land-use within 290 m of each wetland was high or moderately high quality non-breeding amphibian habitat. See Supplementary Material (Appendix 2) for additional information on Tract 4A.

TRACT 5

Tract 5 is located in the northwest corner of WKWMA and covers approximately 279 ha (Figure 1). Tract 5 is crossed by multiple paved and gravel roads, and has several ponds in the area used for recreational activities, especially fishing. Small blocks of forest within a grassland and shrubland matrix characterize this tract. In addition, 48 manmade structures (i.e., "fallout bunkers" from previous ammunition plant) are found within the tract. Using GIS, we determined the presence of 20 wetlands in Tract 5, although four of these wetlands were dropped during field assessment.

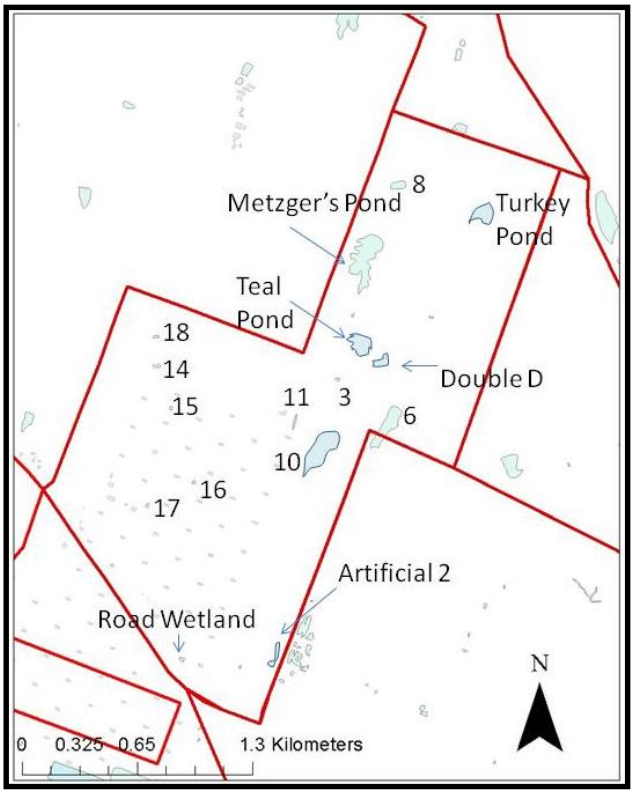


**Figure 13.** Location of assessed wetlands in Tract 5 of the WKWMA.

We examined sixteen wetlands, totaling 7.06 ha, on 10 August 2015 (Figure 13). Wetlands in Tract 5 varied considerably with several artificial wetlands (Double D, Artificial 1), permanent fishing ponds, and regularly inundated wetlands with both low and high canopy cover. Eleven wetlands contained some floating or emergent vegetation and/or partially inundated shrubs that may provide oviposition sites for amphibians. Coarse woody debris within or adjacent to most wetlands in Tract 5 was considered slight or lacking entirely. We documented fish and/or invertebrate predators in 11 wetlands. The remaining wetlands were classified as regularly or seasonally inundated; fish were not detected in these wetlands.

**Figure 14.** Artificial wetland 2 in Tract 5 is regularly inundated (i.e., 25% to 75% of the growing season) and hydroperiod is managed for amphibians and migratory birds.

Five wetlands had canopy cover estimates of > 85% whereas seven wetlands had no canopy cover. Invasive plant species observed in or adjacent to wetlands included Japanese Stilt Grass, cattail *ssp*, and Japanese Honeysuckle. We detected green frogs, bullfrogs, southern leopard frogs, Cope's gray treefrogs, upland chorus frogs, northern cricket frogs and mole salamanders. Given the high densities of wetlands in Tract 5, assessed wetlands were, on average, only 159 m from the nearest wetland. Assessed wetlands averaged 105 m from the nearest roads, although several wetlands (5-6, 5-14, 5-15, "Road Wetland", and "Teal Pond") were < 20 m from the nearest road. The majority of land-use within 290 m of each wetland was grassland and forest; thus we considered Tract 5 to contain high or moderately high quality non-breeding amphibian habitat. See Supplementary Material for additional information on Tract 5.

TRACT 6

Tract 6 covers approximately 480 hectares and composes the entire northern border of the WKWMA abutting the Ohio River (Figure 1). Land cover consists of forest, several active row crop fields, and a few large swamps. Tract 6 is owned by TVA and managed by KDFWR under lease agreement.

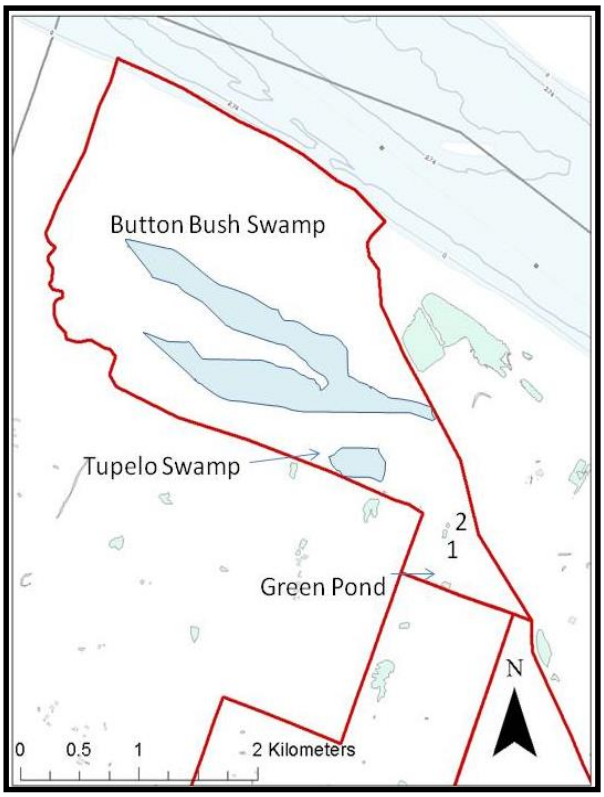


**Figure 15.** Location of assessed wetlands in Tract 6 of the WKWMA

Five wetlands in Tract 6 were assessed totaling 67.09 ha on 13 September 2015 (Figure 15). Included in the wetlands are a 10 ha Tupelo swamp (Figure 17), a 57 ha Button Bush swamp, and three semi-to-permanently inundated wetlands (6-1, 6.2, Green Pond). Due to the apparently permanent hydroperiod of wetlands within Tract 6, floating and emergent vegetation and partially inundated shrubs were evident in every assessed wetland. Canopy exceeded 50% in three of the wetlands; the Button Bush Swamp and Green Pond had canopy covers of approximately 20%. Coarse woody debris was apparent at most wetlands within this tract. We documented fish in three wetlands, yet ten amphibian species were also found including green frogs, Bullfrog, southern leopard frog, Cope's gray tree frogs, green tree frogs (*Hyla cinerea*), upland chorus frog, Fowler's toad, northern cricket frog, smallmouth salamander (*Ambystoma texanum*) and mole salamander. We also noted numerous Slider turtles (*Trachemys scripta*) in the Button Bush Swamp and we frequently observed plain-bellied watersnakes (*Nerodia erythrogaster*) feeding on amphibians, including larval smallmouth salamanders in May 2015, in roadside ditches. We observed Japanese Stilt Grass, Multiflora Rose, Parrotfeather and Japanese Honeysuckle in or adjacent to assessed wetlands.

Wetlands in tract 6 were on average 131 m from the nearest wetland and 75 m from the nearest roads. Green Pond, Tupelo swamp, and button bush swamp were < 20 m from the nearest road. The majority of land-use within 290 m of each wetland was considered high or moderately high quality non-breeding amphibian habitat. See Supplementary Material for additional information on Tract 6.

TRACT 7

Tract 7 covers approximately 116 ha on the northeast corner of WKWMA (Figure 1). Tract 7 is owned by TVA and managed by KDFWR under lease agreement. The area is mostly dominated by shrubs and grasses located under a utility right-of-way. Initially, six wetlands were located within Tract 7, however two wetlands were determined to be inaccessible and dropped from assessment.

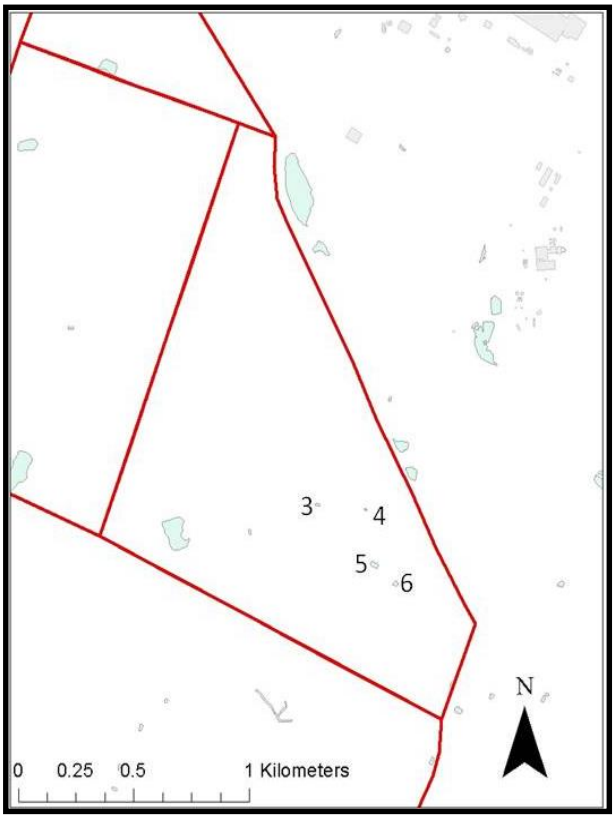


**Figure 16.** Location of assessed wetlands in Tract 7 of the WKWMA

We assessed four, small wetlands totaling 0.09 ha on 13 September 2015 (Figure 16). We considered two wetlands (i.e., 7-4, 7-5) to be permanently or semi-permanently inundated, whereas the other two wetland were dry during assessment and considered regularly inundated. Wetlands 7-4 and 7-6 had canopy cover estimates of > 75% while the other two wetlands had no canopy cover. Invasive plant species observed in or adjacent to wetlands included Japanese Stilt Grass, Multiflora Rose, *Lespedeza ssp.* and Japanese Honeysuckle.

Wetlands in Tract 7 were on average 142.72 m from the nearest wetland. On average, sampled wetlands were 144.93 m from the nearest roads and no wetland was within < 20 m from the nearest road. Some land-use within 290 m of each wetland was considered low quality non-breeding amphibian habitat due to the TVA power plant to the north, however the majority was high or moderately high quality non-breeding amphibian habitat. See Supplementary Material for additional information on Tract 7.

**Figure 17.** Tupelo Swamp in Tract 6 is regularly inundated and potentially offers habitat for a variety of amphibian species.

TRACT 7A

Tract 7A is approximately 438 ha on the eastern side of the WKWMA (Figure 1). This tract contains a large landfill and it is dissected by a paved two lane road. It is composed primarily of grassland and a utility

right-of-way; small patches of hardwood forest are found on the eastern edge. Tract 7A is federal property leased to KDFWR. Using GIS and US ACE wetland layers, 22 wetlands were identified. However, four wetlands were cordoned off or located in close proximity to PGDP. Thus, our assessment focused on 18 wetlands.

We assessed 18 wetlands, totaling 1.37 ha, on 6 September 2015 (Figure 18). Given a large number of wetlands were assessed, we found considerably diversity in hydroperiod, canopy cover and physical structure. We considered 5 wetlands to be permanently or semi-permanently inundated; we documented fish in 3 of these wetlands. We considered the remaining wetlands to be regularly or seasonally inundated. Seven wetlands had canopy cover estimates > 85%, although many of the wetlands, especially those in the utility right-of-way, had no canopy cover. Eleven wetlands in Tract 7A contained some floating or emergent vegetation and/or partially inundated shrubs that may provide oviposition sites for amphibians. Yet, coarse woody debris was low to moderate in the majority of wetlands. Invasive plant species observed included Japanese Stilt Grass, Multiflora Rose, *Lespedeza ssp* and Japanese Honeysuckle. We detected the presence of 8 amphibian species in Tract 7A, including green frogs, Bullfrogs, southern leopard frogs, Cope's gray treefrogs, upland chorus frogs, Fowler's toads, mole salamander, and northern cricket frogs.

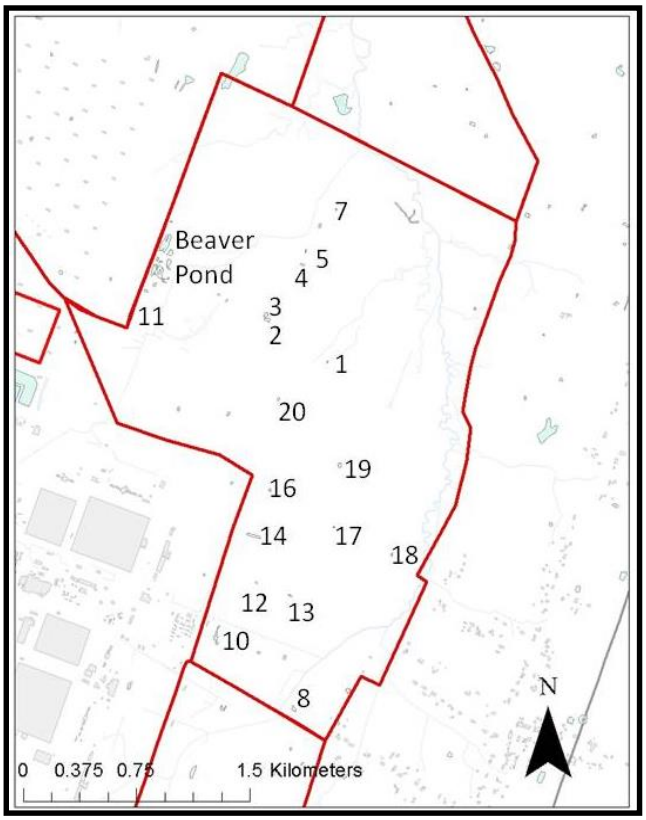


**Figure 18.** Location of assessed wetlands in Tract 7A of the WKWMA

Despite the large number of wetlands in Tract 7A, wetlands were, on average, 261 m from the nearest wetland. On average, sampled wetlands were 163.25 m from the nearest roads and one wetland was within < 20 m from the nearest road. Land-use within 290 m of each wetland was a mixture of high, moderately high, and moderately low habitat depending on proximity of wetland to PDGP or private residences outside of WKWMA. See Supplementary Materials for additional information on Tract 7A.

**Figure 19.** Several regularly or seasonally inundated wetlands were located within the utility right-of-way. The open canopy wetlands offer ideal habitat for a number of amphibian species, including crawfish frogs (*Lithobates aerolatus*).

## DISCUSSION AND GENERAL CONCLUSIONS

Although wetland abundance varied by tract, our assessment concluded that WKWMA has an overall high density of wetlands and a diversity of wetland types. In addition, most wetlands were buffered by high quality terrestrial habitat (i.e., forests, grasslands) within 290 m of each wetland. In general, this suggests that WKWMA may harbor impressive abundances of amphibians and potentially high amphibian species richness. Indeed, our preliminary surveys resulted in the detection of ten species. The potentially high diversity and abundance of amphibians combined with a significant density of wetlands provides for ample research, teaching and outreach opportunities, including biomonitoring with local high school students.

Of the 118 wetlands we assessed, we considered 57 to be regularly or seasonally inundated (i.e., containing water for 25% to 75% of the growing season, See Figure 7). These wetlands are particularly important for amphibians as they contain low densities of amphibian predators. Mole salamanders (Figure 20) and smallmouth salamanders were both found during our habitat assessments at several regularly or seasonally inundated wetland sites, especially those wetlands that contained closed canopies and surrounded by forest. Many salamander species in the genus *Ambystoma* rely on ephemeral ponds or wetlands in forests, habitats that are disappearing from much of the southeastern United States, for reproduction (Petranka 1998). Other salamanders that may be found at WKWMA that favor these habitats for reproduction include spotted salamanders (*A. maculatum*), marbled salamanders (*A. opacum*), tiger salamanders (*A. tigrinum*), four-toed salamanders (*Hemidactylium*

**Figure 20.** A recently metamorphosed mole salamander (*Ambystoma talpodieum*). These animals were often found in wetlands at WKWMA.

*scutatum*), and eastern newts. A number of frog species will also use these wetlands for reproduction including Fowler's toads, southern leopard frogs, Cope's gray treefrogs, western chorus frogs, spring peepers (*Pseudacris crucifer*), eastern narrowmouth toads (*Gastrophryne carolinensis*) and eastern spadefoots (*Scaphiopus holbrookii*). Tracts 1, 2 and 7A contained numerous closed canopy, seasonally inundated wetlands; wetlands within these tracts should be the focus of future amphibian monitoring efforts.

We also found 14 regularly or seasonally inundated wetlands within grassland habitat (See Figure 19). In particular, Tract 7A contained six wetlands that fit this classification. The crawfish frog (*Lithobates aerolatus*) prefers these habitats for reproduction. This species is of particular interest to wildlife biologists in Kentucky due to a tenuous status (Parris and Redmer 2005), its secretive nature (i.e., occupies crayfish burrows during the non-breeding season) and extensive use of terrestrial habitat; these factors have historically prevented extensive research on populations (But see Heemeyer et al. 2012; Heemeyer and Lannoo 2012)). Currently, KDFWR actively manages WKWMA for crawfish frogs through the creation of seasonally inundated wetlands (Square Pond, Bobo Pond, Double D, etc. See Figure 14) and active management of grassland or open landscapes surrounding these wetlands. The naturally occurring wetlands that we documented in our assessment likely provide additional critical breeding habitat for this and other grassland inhabiting amphibian species. Future research should examine if crawfish frogs use these natural, open canopy, seasonal wetlands for reproduction.

**Figure 21.** The 57 ha Button Bush wetland in Tract 6 of the WKWMA likely provides habitat for a variety of amphibians.

Many of the larger wetlands (n = 33) were permanent ponds containing fish, which are known predators of amphibians. However, because of many of these sites had large areas of shallow water and contained dense aquatic vegetation, some amphibian species may be able to persist in high numbers at these sites. For example, we frequently documented bullfrogs, green frogs, cricket frogs (Figure 10), and other species in permanent wetlands. Many of these species employ anti-predatory mechanisms, yet it is possible that other (more palatable) amphibian species use areas of shallow water and thick vegetation for reproduction, although future amphibian surveys will be needed to document this.

The Tupelo swamp (Figure 15) and large Button Bush wetland (Figure 21) in Tract 6 (Figure 15) provide relatively unique wetland habitats that may harbor amphibian species not found elsewhere at WKWMA. These wetland types are primarily restricted to the in the Mississippi Embayment, a northern extension of the Southeastern Coastal Plain, in Kentucky. Several of Kentucky's amphibians are primarily restricted to the Mississippi Embayment; these include the completely aquatic three-toed amphiuma (*Amphiuma tridactylum*) and western lesser siren (*Siren intermedia nettingi*), three lined salamanders (*Eurycea guttolineata*) and bird-voiced tree frogs (*Hyla avivoca*). Another exceptional wetland habitat at WKWMA was the Beaver Pond complex in 7A (Figure 18, 22). During our assessment of this habitat we documented numerous larval and recently metamorphosed mole salamanders, thousands of southern leopard frogs, green frogs and bullfrogs, and vocalizing Cope's gray treefrogs. Future amphibian surveys should focus on these unique habitats.

The numerous created or artificial wetlands on WKWMA also likely provide breeding habitat for a variety of amphibian species and should be monitored in future amphibian research (See Figure 14). These sites are located in four tracts (Tract 1, 2, 4, 5) and vary in age, distance to other wetlands, physical structure and hydroperiod. Studying amphibian assemblages in created wetlands in relation to the naturally occurring wetlands can provide valuable information on restoration techniques, colonization probability

of various species and landscape permeability (Pechman et al. 2001). For example, wetland 12 in Tract 4 was created in fall of 2014; during our habitat assessments in 2015 we detected larval or adult cricket frogs, mole salamanders, southern leopard frogs and bullfrogs. This indicates rapid colonization of wetland 4-12 by amphibians. Relating data collected on local and landscape habitat conditions (i.e., physical structure, distance to nearest wetland, distance to road) to amphibian occurrence and abundance in these wetlands may provide valuable insights into the effectiveness of mitigation wetlands and the necessary spatial arrangement of the wetlands in the landscape to maximize colonization rates.

**Figure 22**. The Beaver wetland Complex in Tract 7A is a likely breeding site for many amphibian species.

The high density and diversity of wetlands and the potential richness of the amphibian communities at the WKWMA provide exceptional opportunities for outreach, teaching, and research. High school students from Marshall High School aided us in our habitat assessments of several artificial wetlands on August 31st. Over a course of a few hours, students were taught the basics about wetlands, amphibians

and sampling techniques used to assess wetlands. During spring 2016, we plan revisiting these same wetlands and relating habitat characteristics to patterns of species distribution and abundance. In addition, we plan to demonstrate the various methods used to sample amphibians. Overall, our long-term goal is to establish a monitoring program for a key indicator group (i.e., amphibians) that is currently a major data gap in ecological investigations at PGDP and WKWMA while teaching local high school students the fundamentals of environmental monitoring and assessment.

# ACKNOWLEDGEMENTS

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## SUPPLEMENTARY MATERIAL
## APPENDIX I: Amphibian Datasheet

## PART I: IN FIELD ASSESSMENT

| **1. Background Information** | | |
|---|---|---|
| Site ID: | Date: | Evaluator: |
| WMA Tract # | UTM E: | UTM N: |

| **2. Wetland Sketch (include N arrow, hydrologic features, plant communities and other habitat features)** |
|---|
| |

| **3. Wetland Physical Structure**<br><br>**A**. Percent of total wetland area (total 100%) | |
|---|---|
| a. Open Water | |
| b. Floating Vegetation (i.e., duckweed) | |
| c. Emergent Vegetation (i.e., cattails) | |
| d. Shrubs | |
| e. Trees | |
| f. Mud Flats | |
| g. Total (should = 100%) | |
| | |
| **B**. Categorize amount of submergent plant /stems/twigs, etc.: **None, Slight, Moderate, Dense or unknown** | |
| **C**. Categorize amount of CWD**: None, Slight, Moderate, Dense or unknown** | |

| **4. Duration of Inundation (check one)** |
|---|
| ☐ Semi- to Permanently Inundated (75% -100% of growing season)<br>☐ Regularly inundated (25%-75% of growing season)<br>☐ Seasonally inundated (12.5 – 25% of growing season)<br>☐ Seasonally saturated soil (little standing water)<br>☐ Unknown |
| 5. Input of water likely from: Surface water (overbank), Groundwater(seep) or precipitation - circle |

**6. Alteration to Natural Hydrologic Regime**

| Low | High | Alteration |
|---|---|---|
| ☐ | ☐ | ditch(es) in or near the wetland |
| ☐ | ☐ | tile(s) in or near the wetland |
| ☐ | ☐ | dike(s) in or near the wetland |
| ☐ | ☐ | weir(s) in or near the wetland |
| ☐ | ☐ | stream channelization |
| ☐ | ☐ | other(s) (specify) |

| Low | High | Alteration |
|---|---|---|
| ☐ | ☐ | stormwater inputs (addition of water) |
| ☐ | ☐ | non-stormwater discharge(s) |
| ☐ | ☐ | road bed(s)/RR grades(s) in or near the wetland |
| ☐ | ☐ | dredging activities in or near the wetland |
| ☐ | ☐ | filling/grading activities in or near the wetland |

****only consider anthropogenic alterations (e.g. exclude beaver activity)**

| 7.Substrate/Soil Disturbance | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Low** | **High** | **Alteration** | **Low** | **High** | **Alteration** | **Low** | **High** | **Alteration** |
| ☐ | ☐ | filling | ☐ | ☐ | human-induced erosion or exposure | ☐ | ☐ | plowing, disking |
| ☐ | ☐ | grading | ☐ | ☐ | human-induced sedimentation or burial | ☐ | ☐ | intensive grazing (hooves) |
| ☐ | ☐ | logging | ☐ | ☐ | Dredging (includes excavating) | ☐ | ☐ | off-road vehicle use |
| ☐ | ☐ | construction | ☐ | ☐ | vehicle use | ☐ | ☐ | other(s) (specify) |

| 8. Canopy Cover | | |
|---|---|---|
| **Evaluator:** | **Pond Center or Edge (circle one)** | |
| **Location** | **% Overstory Density** | **Average** |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

**9. Invasive Plants**

**Selected invasive plant species. Remember to include any species found on the KY-EPPC list that is within the assessment area.**

*(Print the complete KY-EPPC list and take into the field)*

*These native invasive plants are being included for the purposes of the KY-WRAM (i.e., everything on the KY-EPPC list are exotics)

- ☐ *Alliaria petiolata* (Garlic Mustard)
- ☐ *Alternanthera philoxeroides* (Alligator Weed)
- ☐ *Conium maculatum* (Poison Hemlock)
- ☐ *Euonymus fortunei* (Winter Creeper)
- ☐ *Lespedeza cuneata, L. bicolor, L. stipulacea, L. striata, L. thunbergii* (non-native *Lespedeza*)
- ☐ *Ligustrum sinense, L. vulgare* (Privet)
- ☐ *Lonicera japonica* (Japanese Honeysuckle)
- ☐ *Lonicera maackii* (Bush Honeysuckle)
- ☐ *Lythrum salicaria* (Purple Loosestrife)
- ☐ *Microstegium vimineum* (Japanese Stilt Grass)
- ☐ *Myriophyllum aquaticum, M. spicatum* (parrotfeather and Eurasion watermilfoil)
- ☐ *Phalaris arundianacea* (Reed Canary Grass)*
- ☐ *Phragmites australis* (Common Reed)
- ☐ *Polygonum cuspidatum* (Japanese knotweed)
- ☐ *Rhamnus cathartica* (Common Buckthorn)
- ☐ *Rosa multiflora* (Multiflora Rose)
- ☐ *Typha ssp.* (Cattail species)*
- ☐ Other(s): specify below

| **10. Predators/Community Composition** | |
|---|---|
| ☐ Fish Present | Species Seen? |
| ☐ Macroinvert. Predators | Notes: |
| ☐ *A. opacum* | |
| ☐ *N. viridscens* | |

## PART II: GIS ASSESSMENT

**Attachments:** Complete and check (√) each box

- ☐ Attach map of wetland location. Use county road map or USGS 7.5 minute topographic map with location indicated.
- ☐ Attach color photographs of wetland including landscape shot of entire wetland (if possible), vegetation components, habitat types, hydrologic features, and other relevant site features.

| |
|---|
| **1. Wetland Size (ha):** |
| **2. Distance to nearest wetland/pond (m):** |
| **3. Distance to nearest road (m):** |
| |
| **4. Intensity of Surrounding Land Use within 290 m of the Wetland** |
| **If a landuse type in not listed, use the examples below to determine the category. Write in additional land use types here and indicate the land use category you assigned:** |

| **Land Use Category** | Estimate the percent coverage (to nearest 5%) comprised by each of the four categories of land use below. | | |
|---|---|---|---|
| | **Land Use Types:** | **REQUIRED:** Estimate % of each category **here** ↓ | |
| **Very Low**: | ☐ mature forest | ☐ other wetland, lake, stream, pond<br>☐ forested wetland | |
| **Low**: | ☐ shrubland/young forest<br>☐ hay field (non-row crop)<br>☐ lightly managed parkland | ☐ old field<br>☐ single track and two track dirt roads<br>☐ one-lane paved road | |
| **Moderately High**: | ☐ residential & lawns<br>☐ grazed pasture<br>☐ utility right-of-way | ☐ two-lane road<br>☐ railroad | |
| **High**: | ☐ commercial, industrial<br>☐ heavily grazed pasture<br>☐ row crop field | ☐ multi-lane paved roadway<br>☐ construction activity<br>☐ parking lot | |

## APPENDIX II: Detailed Habitat Data for each Tract.

Additional data are available upon request.

**TRACT 1**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 1-1 | 338301 | 4107294 | 0.04 | Permanent | 0 | Moderately High |
| 1-2 | 338310 | 4107237 | 0.68 | Permanent | 0 | Moderately High |
| 1-3 | 338436 | 4107189 | 0.67 | Permanent | 0 | High |
| 1-4 | 338558 | 4107264 | 0.08 | Permanent | 0 | High |
| 1-5 | 338558 | 4107264 | 0.08 | Permanent | 0 | High |
| 1-6 | 338360 | 4107115 | 0.1 | Permanent | 35 | Moderately High |
| 1-7 | 338245 | 4106855 | 0.02 | Permanent | 93.34 | Moderately High |
| 1-8 | 338030 | 4106548 | 0.02 | Regular | 90.48 | Moderately High |
| 1-9 | 338096 | 4106237 | 0.02 | Regular | 88.14 | Moderately High |
| 1-11 | 338679 | 4106759 | 0.01 | Regular | 92.82 | Moderately High |
| 1-13 | 339083 | 4107144 | 0.02 | Permanent | 93.6 | High |
| 1-14 | 339083 | 4107156 | 0.01 | Regular | 98.54 | High |
| 1-15 | 338738 | 4106003 | 0.01 | Seasonal | 15.34 | Low |
| 1-16 | 338837 | 4106033 | 0.06 | Permanent | 35 | Low |
| 1-17 | 339433 | 4106540 | 0.05 | Permanent | 41.86 | Moderately High |
| 1-18 | 339503 | 4107038 | 0.01 | Permanent | 69.42 | Moderately High |
| 1-20 | 339362 | 4106817 | 0.04 | Regular | 95.68 | Moderately High |
| Square Pond | 339756 | 4106994 | 0.78 | Regular | 0 | High |

**TRACT 1A**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 1A-1 | 340216 | 4108383 | 0.04 | Seasonal | 87.36 | Moderately High |
| 1A-2 | 340062 | 4108066 | 0.11 | Permanent | 10 | Moderately High |
| 1A-3 | 340488 | 4107787 | 0.02 | Permanent | 66.3 | Moderately High |
| 1A-4 | 340488 | 4108046 | 0.03 | Regular | 84.5 | High |
| 1A-7 | 340598 | 4108372 | 0.04 | Seasonal | 90.24 | High |
| 1A-10 | 340193 | 4108756 | 0.09 | Regular | 84.5 | Moderately Low |

**TRACT 2**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 2-1 | 336303 | 4106425 | 0.15 | Regular | 15.37 | High |
| 2-2 | 336247 | 4106830 | 0.31 | Permanent | 75 | High |
| 2-3 | 336336 | 4106851 | 0.02 | Regular | 0 | High |
| 2-5 | 336562 | 4106890 | 0.02 | Permanent | 98.8 | Moderately Low |
| 2-6 | 336764 | 4107010 | 0.51 | Permanent | 0 | High |
| 2-7 | 336821 | 4106915 | 0.06 | Permanent | 0 | High |
| 2-9 | 336757 | 4106899 | 0.07 | Regular | 93.34 | High |
| 2-10 | 336736 | 4106841 | 0.25 | Permanent | 0 | Moderately High |
| 2-11 | 336785 | 4106801 | 0.03 | Permanent | 9.54 | High |
| 2-12 | 336716 | 4106763 | 0.35 | Permanent | 0 | Moderately High |
| 2-13 | 336669 | 4106711 | 0.03 | Permanent | 0 | Moderately High |
| 2-14 | 336995 | 4106632 | 0.26 | Regular | 25 | High |
| 2-15 | 337082 | 4106745 | 0.11 | Permanent | 42.67 | High |
| 2-16 | 337275 | 4106555 | 0.04 | Regular | 71.82 | Moderately High |
| 2-17 | 336492 | 4107368 | 0.82 | Permanent | 0 | High |
| 2-18 | 336614 | 4107442 | 0.56 | Permanent | 24.29 | High |
| 2-19 | 337174 | 4107212 | 0.15 | Permanent | 70.1 | Moderately High |
| 2-20 | 337311 | 4107533 | 0.03 | Permanent | 99.3 | Moderately High |
| 2-21 | 337796 | 4107368 | 0.03 | Regular | 100 | Moderately High |
| Rice Springs | 336171 | 4106712 | 0.15 | Regular | 0 | High |
| Robinson Pond | 336330 | 4107043 | 1.59 | Permanent | 0 | High |
| Box factory Pond 1 | 336672 | 4108152 | 0.9 | Permanent | 0 | High |
| Box factory Pond 2 | 336708 | 4108166 | 0.63 | Permanent | 0 | High |
| Box factory pond 4 | 336737 | 4108256 | 1.17 | Permanent | 0 | High |
| Box factory pond 5 | 336773 | 4108287 | 0.55 | Permanent | 0 | High |

**TRACT 2A**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 2A-4 | 338201 | 4108019 | 0.03 | Regular | 90.74 | Moderately High |
| 2A-5 | 338129 | 4108019 | 0.07 | Regular | 92.04 | Moderately High |
| 2A-6 | 338262 | 4108027 | 0.03 | Permanent | 76.44 | Moderately High |
| 2A-8 | 337774 | 4108148 | 0.02 | Regular | 92.82 | Moderately High |

**TRACT 3**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 3-2 | 336262 | 4108348 | 0.04 | Regular | 94.12 | High |
| 3-3 | 336270 | 4108402 | 0.03 | Seasonal | 94.12 | High |
| Box factory pond 6 | 336718 | 4108267 | 0.3 | Permanent | 0 | High |
| Box factory pond 7 | 336661 | 4108228 | 1.33 | Permanent | 0 | High |
| Box factory Wetland | 336691 | 4108159 | 0.02 | Permanent | 0 | High |

**TRACT 4**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 4-1 | 337316 | 4109763 | 0.49 | Permanent | 20 | High |
| 4-2 | 337403 | 4104844 | 1.36 | Permanent | 0 | High |
| 4-5 | 337566 | 4110087 | 0.02 | Permanent | 86.58 | High |
| 4-7 | 337314 | 4110173 | 0.02 | Permanent | 85.28 | Moderately High |
| 4-8 | 338176 | 4110517 | 0.05 | Permanent | 60.06 | High |
| 4-12 | 338214 | 4110622 | 0.58 | Permanent | 0 | Moderately Low |
| 4-14 | 337463 | 4109994 | 0.15 | Permanent | 0 | High |
| 4-15 | 336314 | 4109519 | 0.02 | Permanent | 70.72 | Moderately High |
| 4-16 | 336240 | 4109604 | 0.02 | Seasonal | 96.2 | Moderately High |
| 4-17 | 336575 | 4109576 | 0.02 | Permanent | 86.58 | High |
| 4-18 | 336654 | 4109779 | 0.01 | Seasonal | 89.96 | High |
| Artificial 3 | 336814 | 4109860 | 0.07 | Permanent | 0 | Moderately High |
| Artificial 4 | 336886 | 4109776 | 0.07 | Permanent | 0 | Moderately High |
| Qualifying Pond | 336421 | 4109659 | 0.05 | Permanent | 0 | High |
| Disabled Access Pond | 337121 | 4109367 | 2.26 | Permanent | 0 | Low |

**TRACT 4A**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 4A-1 | 337394 | 4109347 | 0.01 | Permanent | 96.2 | Moderately High |
| 4A-2 | 337431 | 4109744 | 0.02 | Permanent | 100 | High |
| 4A-3 | 337974 | 4110059 | 0.04 | Regular | 96.98 | High |
| 4A-4 | 338047 | 4110070 | 0.02 | Permanent | 43.16 | High |

**TRACT 5**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 5-3 | 340138 | 4111896 | 0.02 | Permanent | 80.86 | High |
| 5-6 | 340316 | 4111659 | 0.95 | Permanent | 0 | High |
| 5-8 | 340426 | 4112756 | 0.2 | Permanent | 0 | Moderately High |
| 5-10 | 340088 | 4111609 | 1.3 | Permanent | 0 | High |
| 5-11 | 339038 | 4111703 | 0.05 | Permanent | 89.7 | High |
| 5-14 | 339323 | 4111968 | 0.03 | Permanent | 93.08 | High |
| 5-15 | 339385 | 4111778 | 0.02 | Regular | 94.64 | High |
| 5-16 | 339477 | 4111442 | 0.02 | Regular | 95.16 | High |
| 5-17 | 339267 | 4111339 | 0.02 | Permanent | 92.04 | High |
| 5-18 | 339266 | 4112100 | 0.03 | Regular | 82.94 | Moderately High |
| Turkey Pond | 340841 | 4112644 | 0.43 | Permanent | 0 | High |
| 5-Road wetland | 339414 | 4110649 | 0.4 | Seasonal | 25 | Moderately High |
| Double D | 340323 | 4111871 | 0.27 | Regular | 0 | High |
| Teal Pond | 340270 | 4112059 | 1.15 | Permanent | 0 | High |
| Metzger's Pond | 340277 | 4112422 | 1.85 | Permanent | 0 | High |
| Artificial 2 | 339827 | 4110634 | 0.32 | Regular | 0 | High |

**TRACT 6**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 6-1 | 340709 | 4113337 | 0.11 | Permanent | 54.08 | High |
| 6-2 | 340729 | 4113390 | 0.05 | Permanent | 91 | High |
| Green Pond | 340702 | 4113026 | 0.19 | Permanent | 15 | High |
| Tupelo swamp | 339847 | 4113998 | 9.78 | Permanent | 100 | Moderately High |
| Button bush | 339741 | 4114594 | 56.96 | Permanent | 20 | Moderately High |

**TRACT 7**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 7-3 | 341402 | 4111574 | 0.02 | Regular | 0 | Moderately Low |
| 7-4 | 341571 | 4111554 | 0.01 | Permanent | 75.92 | Low |
| 7-5 | 341598 | 4111376 | 0.04 | Permanent | 0 | Moderately High |
| 7-6 | 341671 | 4111310 | 0.02 | Regular | 80 | Moderately High |

**TRACT 7A**

| Wetland | UTM E | UTM N | Area | Inundation | Canopy | Non-breeding habitat |
|---|---|---|---|---|---|---|
| 7A-1 | 340816 | 4110157 | 0.01 | Permanent | 0 | Low |
| 7A-2 | 340496 | 4110385 | 0.04 | Permanent | 0 | Low |
| 7A-3 | 340496 | 4110385 | 0.04 | Seasonal | 0 | Low |
| 7A-4 | 340684 | 4110671 | 0.02 | Regular | 0 | Low |
| 7A-5 | 340705 | 4110734 | 0.01 | Seasonal | 1.56 | Moderately High |
| 7A-7 | 340871 | 4110946 | 0.01 | Seasonal | 0 | Low |
| 7A-11 | 339859 | 4110550 | 0.02 | Permanent | 90 | Moderately High |
| 7A-12 | 340412 | 4109028 | 0.01 | Seasonal | 0 | Moderately Low |
| 7A-13 | 340590 | 4108962 | 0.01 | Regular | 0 | Moderately Low |
| 7A-14 | 340409 | 4109275 | 0.08 | Regular | 96.2 | Moderately Low |
| 7A-16 | 340495 | 4109505 | 0.01 | Seasonal | 90.22 | Moderately Low |
| 7A-17 | 340829 | 4109309 | 0.01 | Seasonal | 91.26 | Moderately High |
| 7A-18 | 341133 | 4109162 | 0.01 | Seasonal | 83.46 | High |
| 7A-19 | 340862 | 4109622 | 0.03 | Seasonal | 20.54 | Moderately High |
| 7A-20 | 340546 | 4109975 | 0.02 | Permanent | 91.52 | Moderately High |
| Beaver Pond | 339902 | 4110662 | 0.76 | Permanent | 90.76 | Low |