St. Louis District

Environmental Pool Management 2018 Summary Report

June 2019

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Cover photo: Vegetation supported by environmental pool management (Ben McGuire, U.S. Fish and Wildlife Service - USFWS, formerly U.S. Army Corps of Engineers – USACE)

SUSTAINABLE RIVER PROGRAM

ENVIRONMENTAL POOL MANAGEMENT 2018 SUMMARY REPORT

ST. LOUIS DISTRICT

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1.1 Project Area (Figure 1)

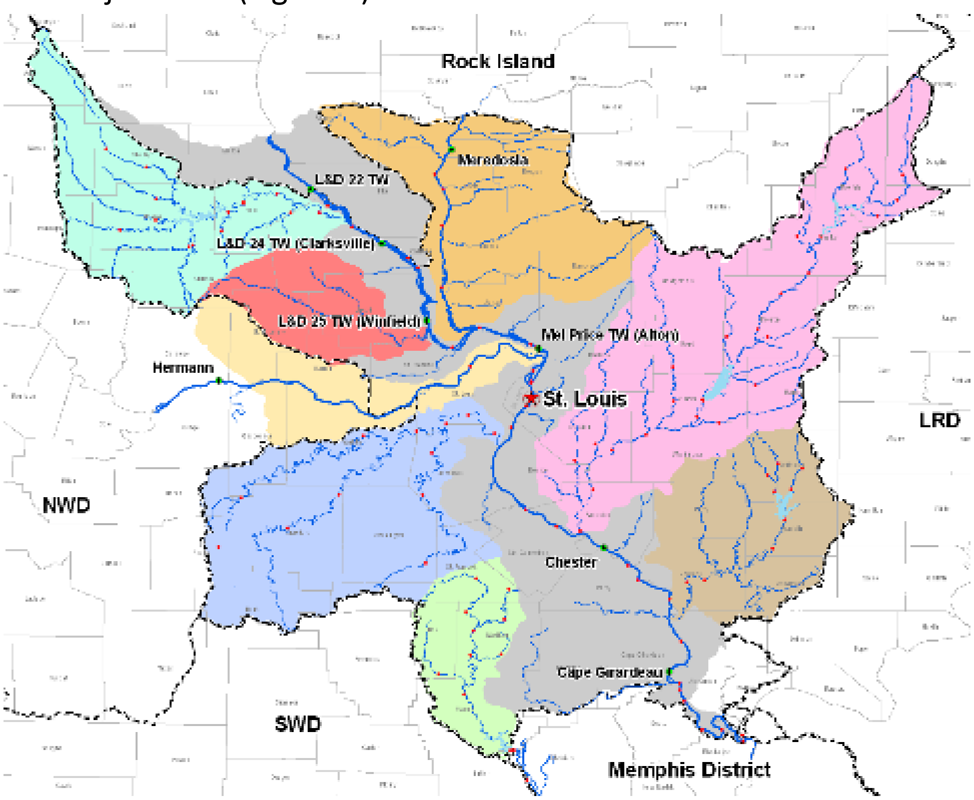

Figure 1. Watershed map of St. Louis District displaying HUC 4 units.

1.2 Introduction

Twenty years of managing Pools 24-26 below maximum regulated pool during the summer growing season for 30-40 days shows that ecological conditions could be significantly enhanced for annual emergent aquatic plants production (moist-soil plants). River shoreline, interior island wetlands and island fringe areas, which are exposed from the reduction are consistently revegetated with species such as smartweed (*Polygonum* spp.), millet (*Echinochloa* spp.), sedges (*Carex* spp.), Amazon sprangletop (*Leptochloa panicoides*), flatsedge (*Cyperus* spp.) etc. Seed production of these plants are valuable for resident and migratory waterbirds but also provide, bank stabilization, nutrient processing, sediment deposition, invertebrate habitat, egg-laying structure for fish and amphibians, food for aquatic reptiles, cover and nursery habitat for juvenile fish, etc. Long term fisheries monitoring indicate that native fish species are not negatively affected by this change. In fact, in Pool 25 it has been found that water level management for growing this type of plant community benefits riverine fish communities as a whole (Garvey *et al* 2003). Furthermore, nominal commercial and recreational issues have been reported as a result of the pool water level changes. Twenty years of demonstration indicates this is a beneficial practice to balance the needs of navigation with the needs of the ecosystem.

Prolonged high flow conditions upstream in 2014 necessitated an 86 day drawdown in lower Pool 26. River biologists observed this atypical condition produced not only annual aquatic vegetation but also perennial aquatic vegetation, such as arrowhead (*Sagittaria* spp.), American lotus (*Nelumbo lutea*), and spatterdock (*Nuphar lutea*). These observances demonstrated that it is still possible to grow perennial aquatic vegetation in this portion of the Upper Mississippi River (UMR). Prior to 1994, perennial aquatic vegetation was common in back waters of lower Pool 26. Currently however, perennial aquatic vegetation only exists within one backwater area in Pool 26. In the more northern pooled portion of the UMR, both annual and perennial plants have responded positively to reduced water level conditions when the reduction is targeted for 90 days of the growing season. Additionally, two consecutive years of water level reduction promotes perennial tubers, which can dramatically increase in size (up to 16 X first year growth) and persist for over six years after reflooding. The unique conditions of 2014 shows a restoration goal to regenerate a mix of annual and perennial aquatic vegetation is possible within the lower section of the UMR and would provide additional benefits to physical river function and biological resources.

In the fall 2014, river biologists again asked the Corps if the 30-40 day reduction could be extended to 90 or more days to improve conditions for annual and perennial aquatic plant response. The Corps said if hydrologic conditions provided an opportunity, they would attempt to manage pools 24-26 below full pool beginning as the spring flood waters receded. After coordinating with other state and federal natural resource managers it was decided to begin the reduction as the spring water levels receded in each of the three pools and depending on hydrologic conditions maintain that level for 90 or more days.

The St. Louis District of the Corps of Engineers attempted to maintain the water levels below maximum regulated pool in Pools 24-26 for most of the summer of 2015, beginning in April. An increase in flow around mid-June interrupted continuous reduction in all three pools but the Corps did return to reduced water levels after the flood waters receded. Due to the height of the flood and duration, all the plants were lost during inundation. However, the growth after the flood produced similar vegetative response and continued until water levels were brought back up to full pool by October 1, 2015.

The St. Louis District of the Corps of Engineers maintained the water levels below full pool in Pools 24-26 (Table 1, Figures 2 and 3) for the summer of 2016, beginning in April. Optimum river flows allowed pools levels to be maintained in Pool 26 for 110 days at 2’ below full pool, in Pool 25 for 139 days at 1.5’ below full pool and in Pool 24 for 97 days at 1’ below full pool. These conditions produced large amounts of vegetation coverage and higher species diversity as the growing season continued. This is particularly important for the resiliency of the aquatic ecosystem, in that the longer growing season created favorable conditions for perennial species that have been lacking compared to historic conditions.

2018 concluded the four-year experimental longer-duration water level reduction in Pools 24-26 (Figures 4, 5, and 6).

Table 1. Lock and dam operation limits in terms of pool elevations for L&D 26, 25, and 24.

Location	Upper Limit (ft)	Lower Limit (ft)	Hinge Point Limits (ft)
Lock & Dam 24	449.0	445.5	11.5-12.2
Lock & Dam 25	434.0	429.7	434.0-437.0
Lock & Dam 26 (Melvin Price)	419.0	412.5	14.2-16.2

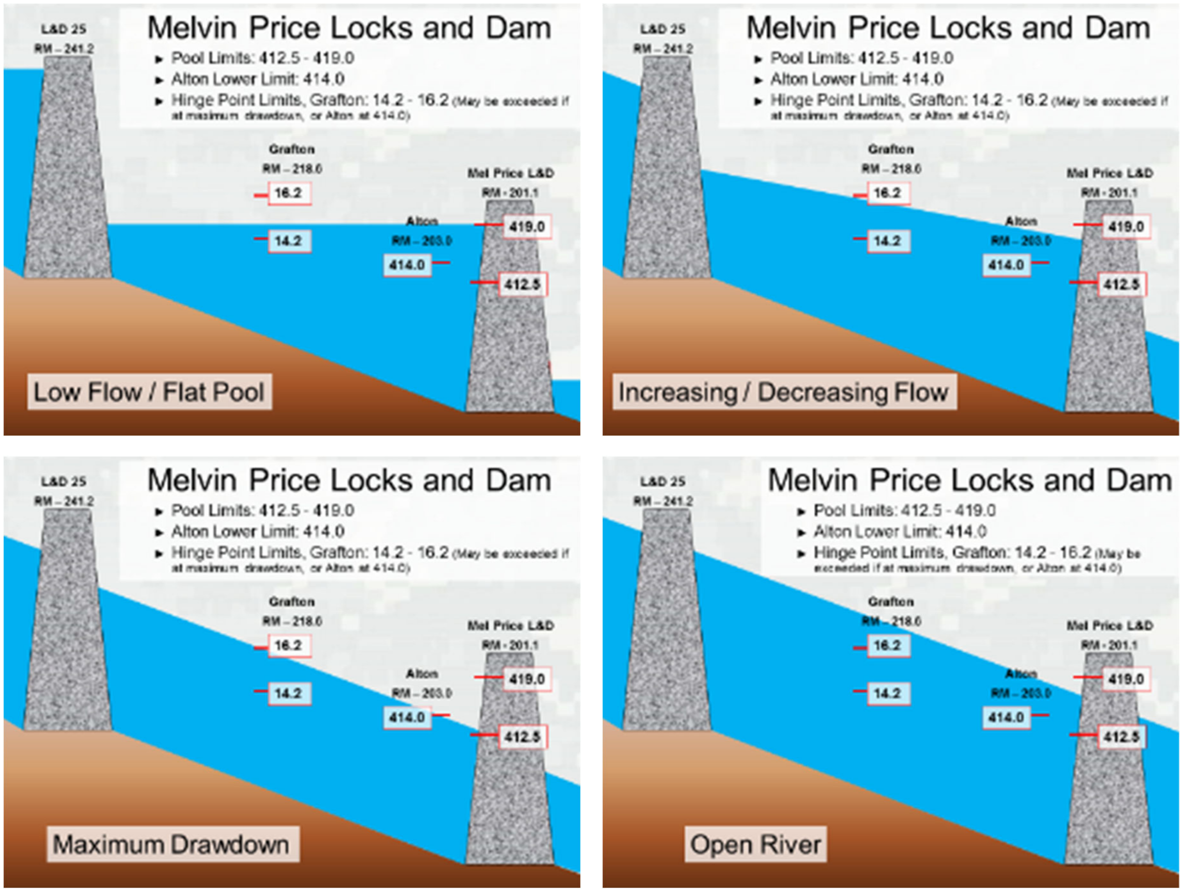

Figure 2. Schematics depicting water levels with upper and lower dam point and upper and lower hinge point elevations at Mel Price Locks and Dam during low flow/flat pool (upper left), increasing/decreasing flow (upper right), maximum drawdown (lower left), and open river (lower right).

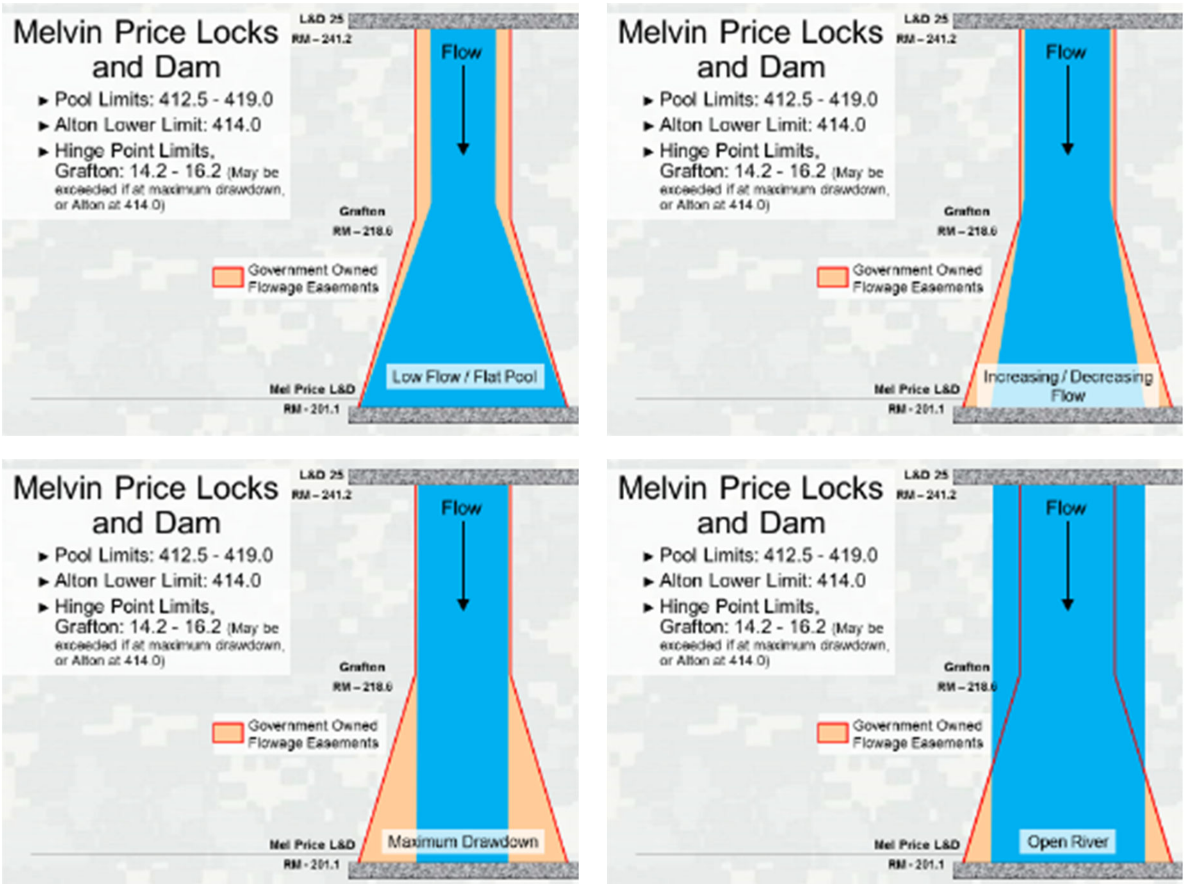

Figure 3. Schematic depicting water conveyance and USACE owned flowage easements during low flow/flat pool (upper left), increasing/decreasing flow (upper right), maximum drawdown (lower left), and open river (lower right).

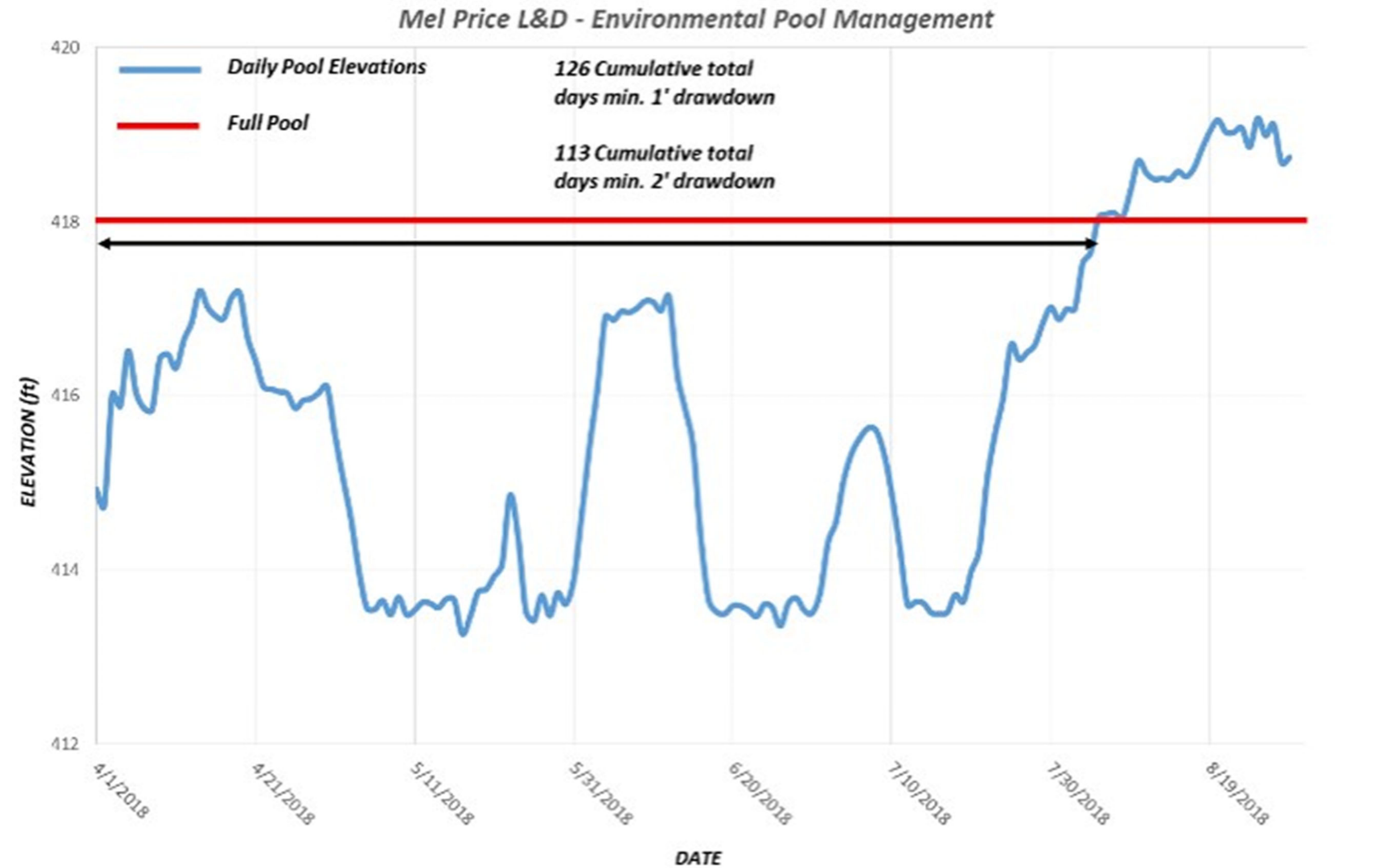

Figure 4. Hydrograph of Pool 26 showing actual elevations (blue) and target pool elevation (red) during EPM.

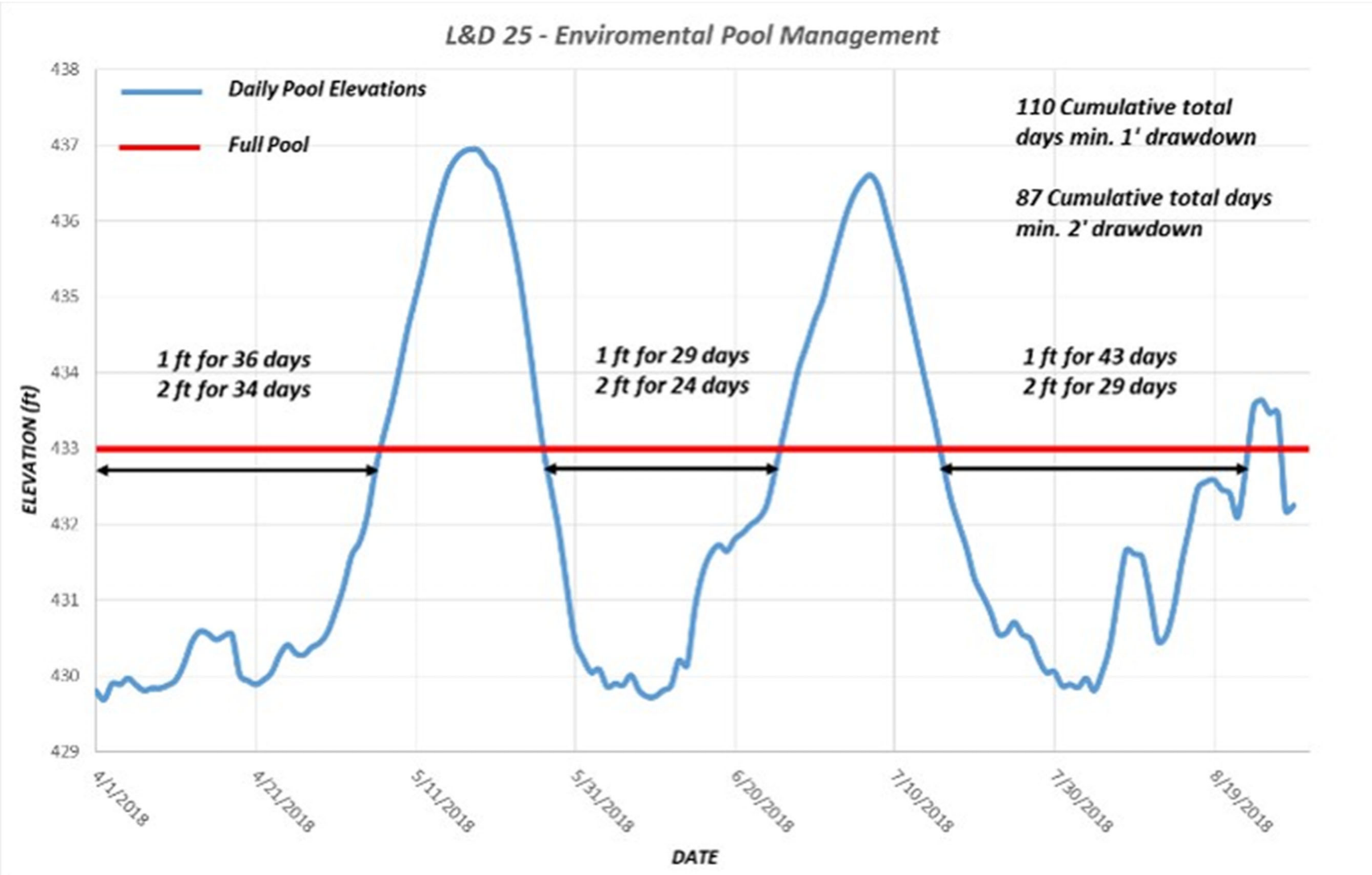

Figure 5. Hydrograph of Pool 25 showing actual elevations (blue) and target pool elevation (red) during EPM.

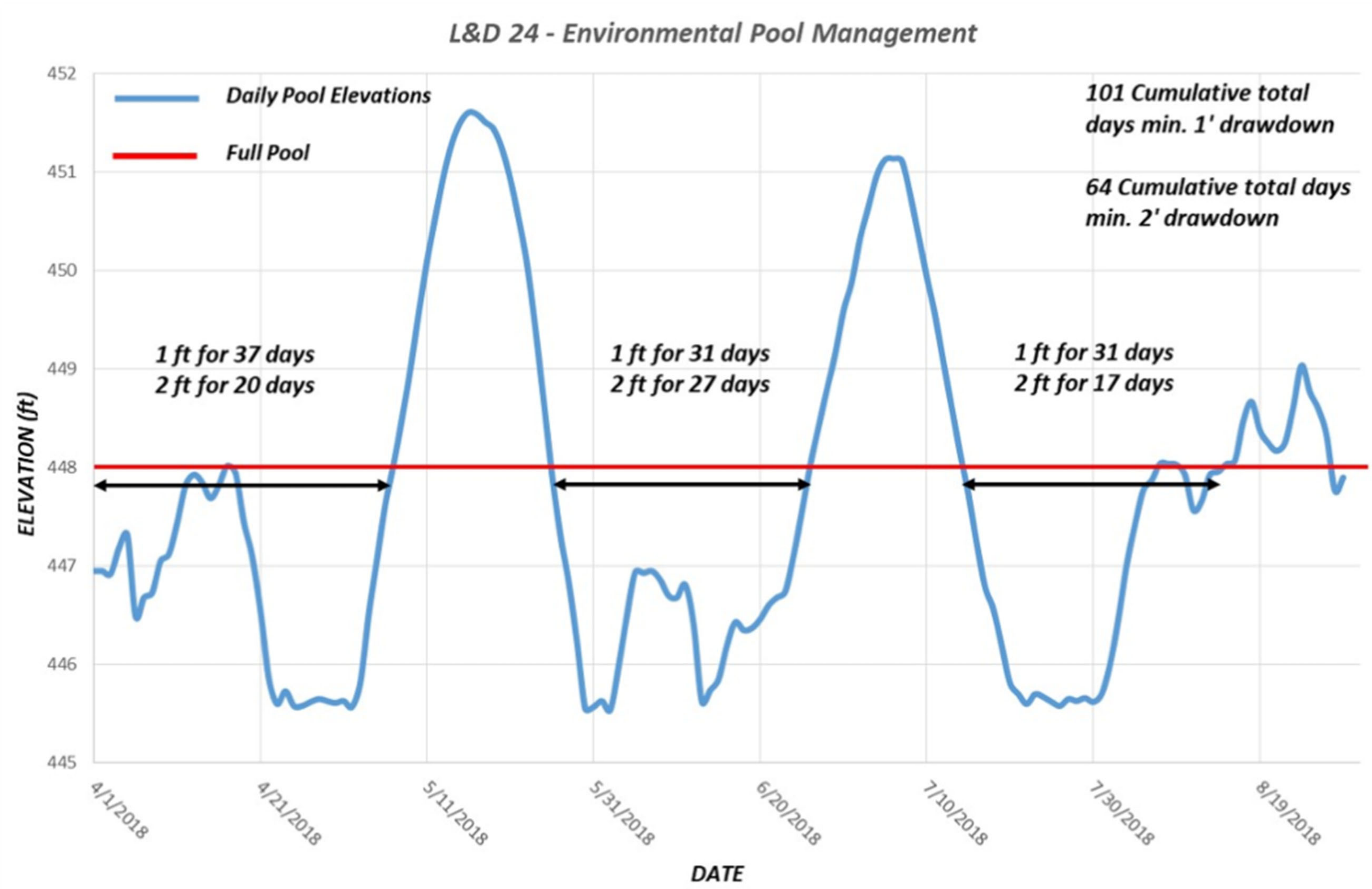

Figure 6. Hydrograph of Pool 24 showing actual elevations (blue) and target pool elevation (red) during EPM.

Chapter 2 Vegetation Surveys

2.1 Site Selection

An aerial imagery analysis was conducted to locate areas with exposed mudflat during the growing season in previous EPM implemented years. Potential sites were identified and a target of five sites per pool was set to have a large enough data set and attain measurable results. Site selection preference was given to sites with larger overall area as well as connection with the river. Sites disconnected from the river or that contained a water control structure of some sort were not included due to a difference in hydrology compared to the river. In addition, professional judgment and knowledge from field personnel was taken into account for known locations where emergent vegetation occurred in previous years. However, due to the structure and variance of geomorphology between pools, average site sizes and locations varied between pools. For example, Pool 26 contains more connected backwater locations with larger overall areas compared to Pools 25 and 24 (Table 2 and Figure 7). Site selection was as follows for each pool: Pool 26 Dresser Island Conservation Area, Alton Lake, Ellis Bay, Mile 210 Area, Piasa Island (Figure 8); Pool 25, Batchtown (exterior), Turner Island, Jim Crow Island, Hausgen Island, Stag Island (Figure 9); Pool 24, Middleton Island, Pharrs Island, Crider Island, Gosline Island, Ducher Island (Figure 10).

Table 2. Table showing total acreage by site.

Pool 26		**Pool 25**		**Pool 24**	
Site	**Acres**	**Site**	**Acres**	**Site**	**Acres**
Alton Lake	210	Turner Island	4.3	Middleton Island	9.2
Dresser	45.4	Jim Crow Island	2.3	Crider Island	14.0
Mile 210	28.3	Hausgen Island	2.5	Gosline Island	10.4
Ellis Bay	39.1	Stag Island	1.3	Ducher Island	6.2
Piasa Island	40.7	Batchtown (exterior)	3.0	Pharrs Island	5.0

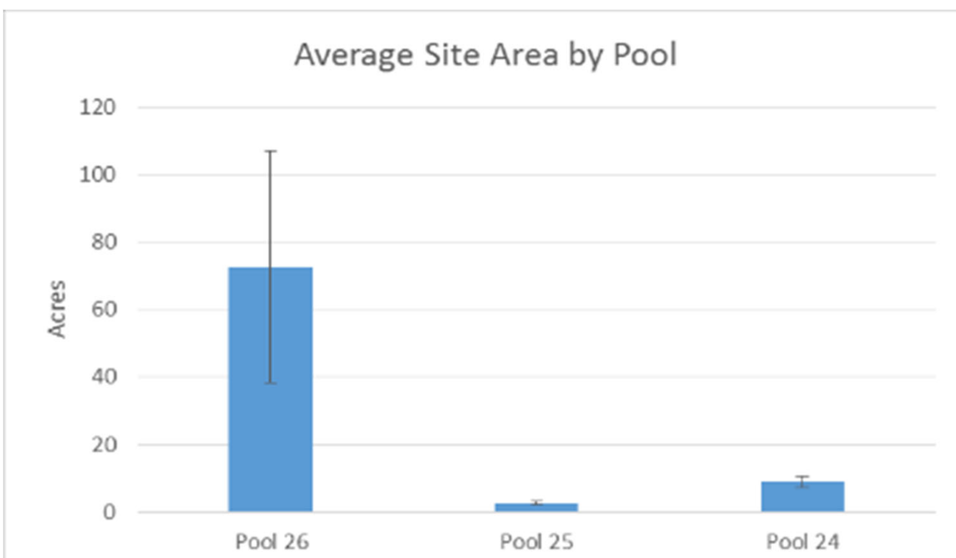

Figure 7. Average size of vegetation survey sites (in acres) by pool with standard error bars.

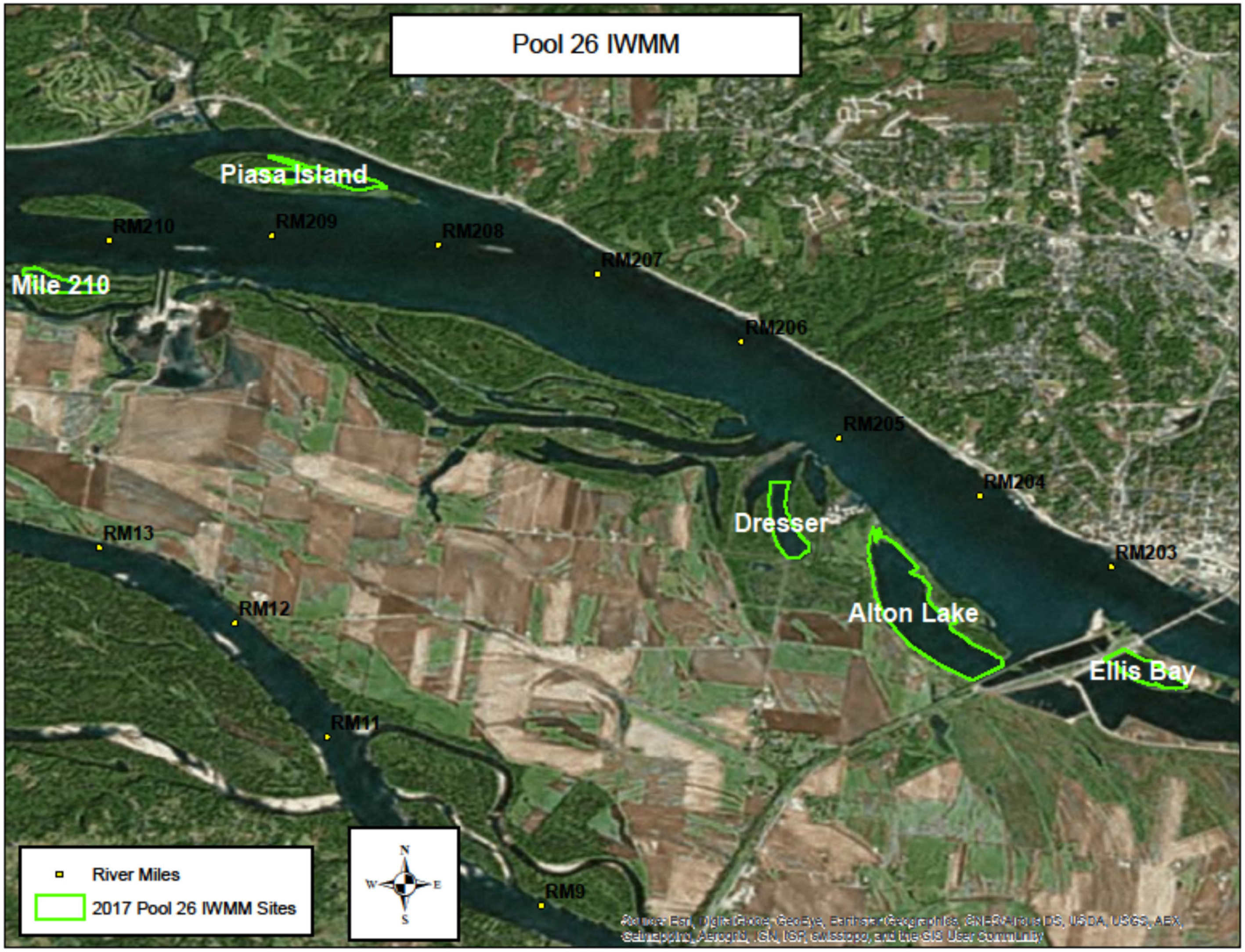

Figure 8. Pool 26 selected sites with acreages. Sites include: Dresser Island Conservation Area, Alton Lake, Ellis Bay, Mile 210, and Piasa Island.

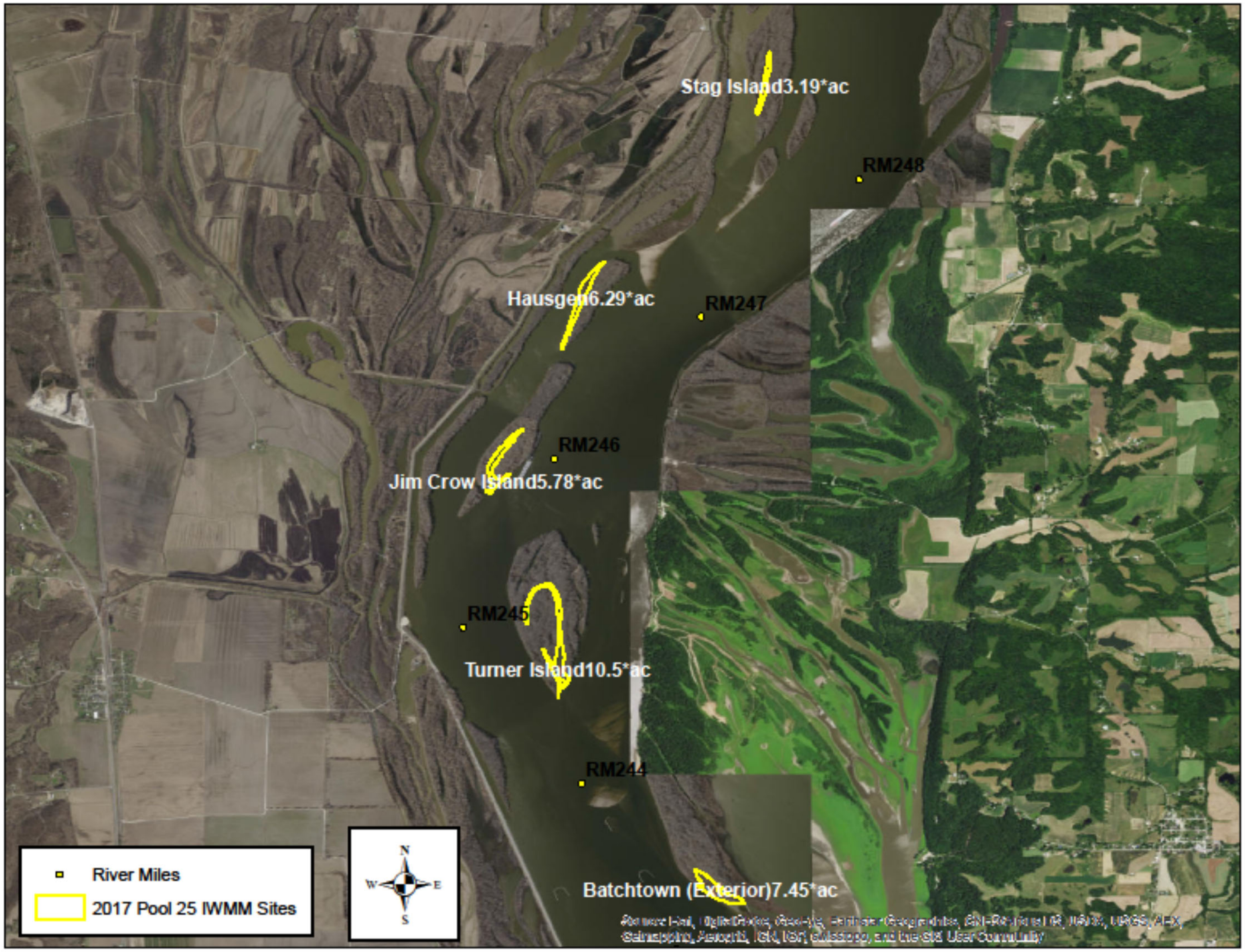

Figure 9. Pool 25 selected sites with acreages. Sites include: Batchtown (exterior), Turner Island, Jim Crow Island, Hausgen Island, Stag Island.

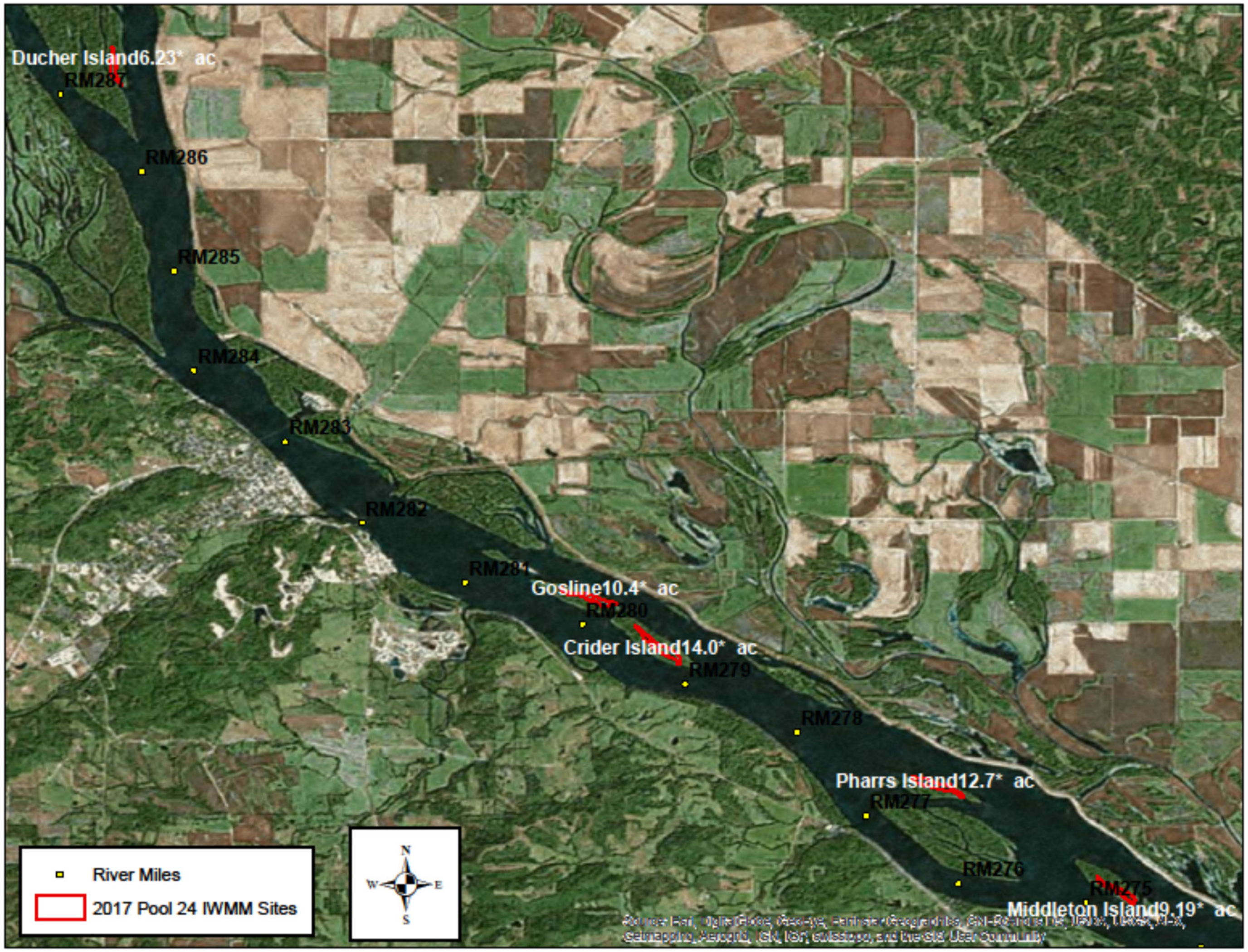

Figure 10. Pool 24 selected sites with acreages. Sites include: Middleton Island, Pharrs Island, Crider Island, Gosline Island, and Ducher Island.

2.2 Long Term Resource Monitoring Vegetation Surveys

The lower half (RM 201-221) of Pool 26 was sampled using the Long Term Resource Monitoring Vegetation Survey Protocol, Yin *et al* 2000. Within each site, plot locations were determined using the LTRM Stratified Random Sampling design, where a 50 x 50 meter grid is generated and overlaid into a GIS map. Nodes of the grid are geo-spatially registered with coordinates generated. Nodes that fall within the sites and 1.5 meters or greater in water depth were selected as vegetation survey plot locations. This was done for the lower half of Pool 26, RM 201-221. In total, 78 plots were generated (Figure). At each plot location, sampling is normally done via a boat and a total of six subplots are located off each corner of the boat and off the port and starboard sides of the boat. Each subplot is assigned a percent cover estimate using a rating of 0 to 5. The cover rating relating to species percent cover is as follows: 0 = None; 1 = 1-20%; 2 = 21-40%; 3 = 41-60%; 4 = 61-8-%; 5 = 81-100%. A cover rating was assigned to each species within each subplot.

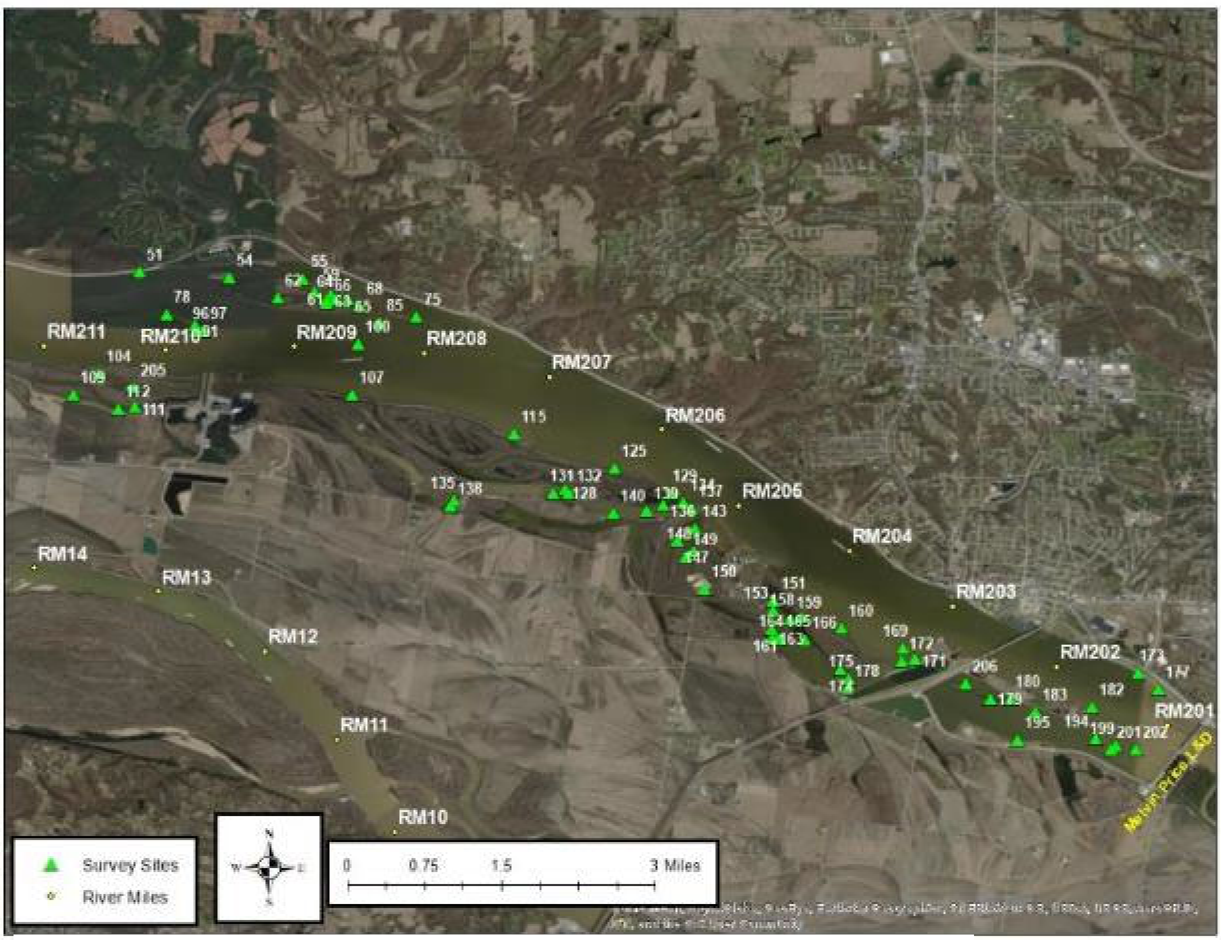

Figure 11. LTRM vegetation survey points in Pool 26, RM 201-221.

Although this vegetation survey protocol is primarily designed for sampling submersed aquatic vegetation via a boat, in Section 1.4.3 of the LTRM vegetation sampling protocol, *Unusual Situations* describes circumstances in which emergent aquatic vegetation sampling can be done on the ground. When utilizing this approach, the subplots are estimated visually as to their approximate location as if sampling was done from a boat.

Average species percent cover (Figure 12), percent frequency of occurrence (Figure 13), and species richness were calculated. Simpson's diversity index (Figure 14), Shannon's diversity index, and Simpson's evenness were calculated.

Table 3. Table of all species encountered during LTRM-type vegetation surveys.

Species Code	Latin Name	Common Name
ACSA2	Acer saccharinum	Silver maple
ACNE	Acer negundo	Boxelder
AMCO	Ammonnia coccinea	Valley redstem
AMSP	Amaranthus spp.	Pigweed spp.
ARAN	Artemisia annua	Sweet sagewort
ASIN	Asclepias incarnata	Swamp milkweed
ASSP	Aster spp.	Daisy spp.
BISP	Bidens spp.	Beggarticks
CASP	Carex spp.	Sedge spp.
CEOC	Cephalanthus occidentalis	buttonbush
CHFA	chamaecrista fasciculata	partridge pea
CODI	Commelina diffusa	climbing dayflower
CYSP	Cyperus spp.	Flatsedge spp.
DEIL	Desmanthus Illinoensis	Illinois bundleflower
ECSP	Echinochloa spp.	millet species
ECCR	Echinochloa crusgalli	Barnyard grass
ECWA	Echinochloa walteri	Walter's millet
ECPR	Eclipta prostrata	False daisy
ELSP	Eleocharis spp.	Spikerush spp.
ERHY	Eragrostis hypnoides	Teal lovegrass
EUSP	Eupatorium spp.	Thoroughwort spp.
FOAC	Forestiera acuminata	swamp privet
HUJA	Humulus japonicus	Japanese hops
HILA	Hibiscus laevis	Rosemallow
IPSP	Ipomoea spp.	Morning glory species
IVAN	Iva annua	sumpweed
LEOR	Leersia oryzoides	Rice cutgrass
LEPA	Leptochloa panicoides	Amazon sprangletop
LIDU	Lindernia dubia	Yellowseed false pimpernel
LINO	Lippia nodiflora	Frog fruit
LIMI	Limna minor	Duckweed
LUSP	Ludwigia spp.	Water primrose spp.
LYER	Lycopus americana	American bugleweed
MIAL	Mimulus alatus	Sharpwing monkeyflower
MORU	Morus rubra	Red Mulberry
NELU	Nelumbo lutea	American lotus
PASP	Panicum spp.	Panicum spp.
PEDI	Penthorum sedoides	Ditch stonecrop
PHAU	Phragmites australis	Phragmites (common reed)
PHLA	Phyla lanceolata	Lanceleaf frogfruit
PHVI	Physostegia virginiana	Obedient Plant
PLOC	Platanus occidentalis	american sycamore
POLA	Polygonum lapathifolium	Curlytop smartweed
POPE	Polygonum pensylvanicum	Pennsylvania smartweed
POPE2	Polygonum persicaria	Lady's thumbprint smartweed
ROSE	Rorippa sessiliflora	sessile-flowered yellow cress
RUSP	Rumex spp.	Dock spp.
SALA	Sagittaria latifolia	Broadleaf arrowhead
SAEX	Salix exiqua	sandbar willow
SANI	Salix nigra	Black willow
SANI2	Sambucus nigra	Elderberry
SESP	Setaria spp.	Setaria spp.
SYLA	Symphyotrichum lanceolatum	White panicle aster
SYPR	Symphyotrichum praealtum	Willowleaf aster
ULAM	Ulmus americana	American elm
VEHA	Verbena hastata	Swamp verbena
XASP	Xanthium spp.	Cocklebur species

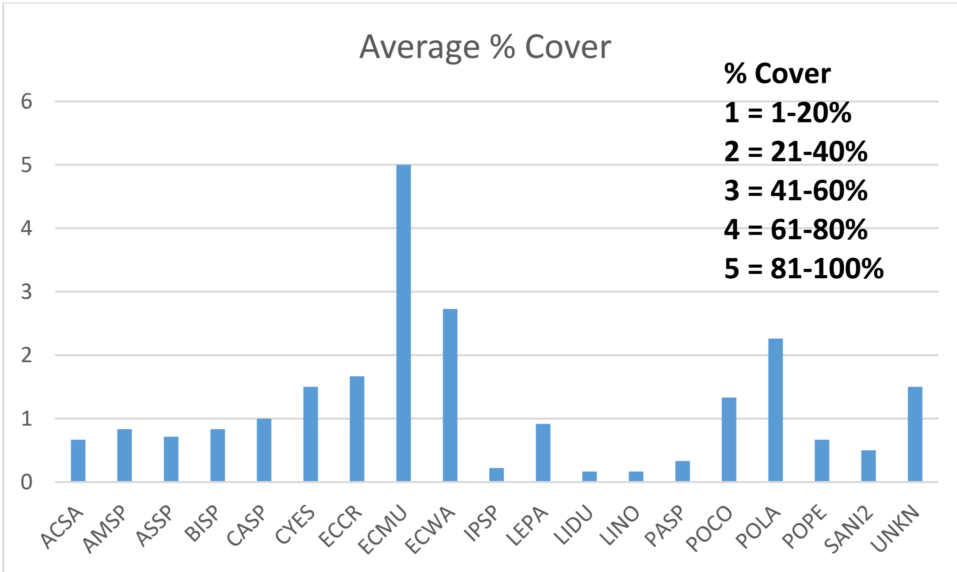

Figure 7. Pool 26 average percent cover from LTRM vegetation survey.

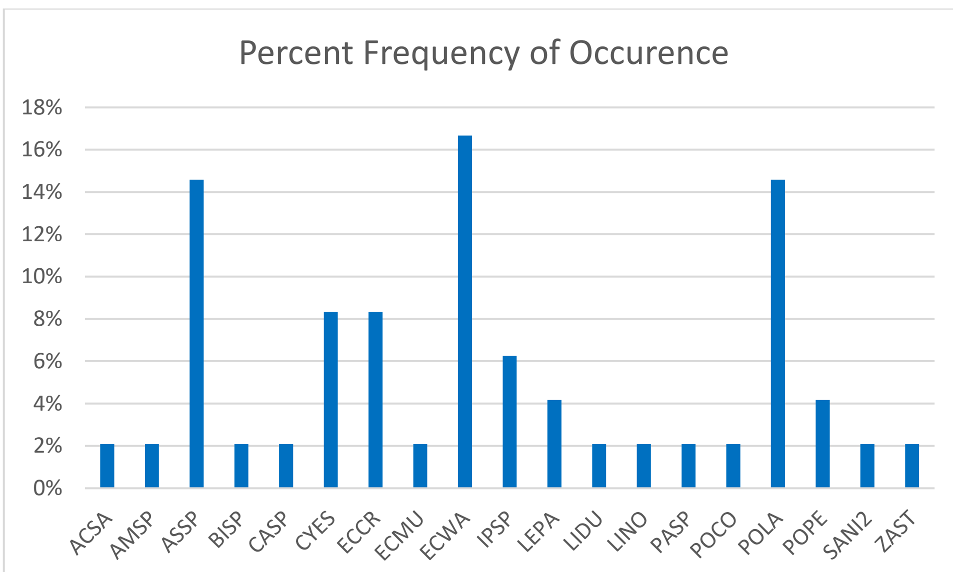

Figure 8. Pool 26 species percent frequency of occurrence for LTRM surveys.

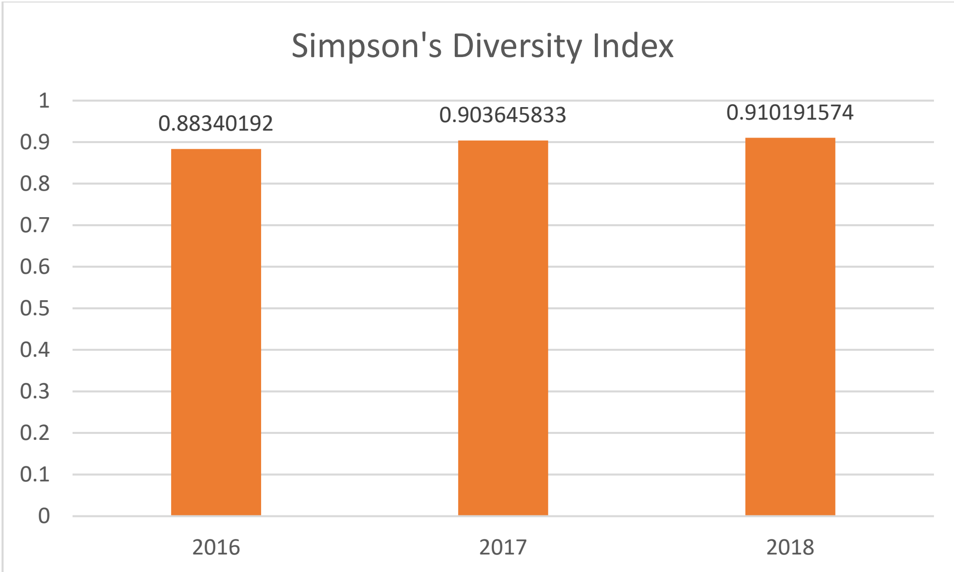

Figure 9. Shannon's diversity index, Simpson's diversity index, and Simpson's evenness Pool 26 LTRM vegetation surveys.

In total, 55 species and one unknown species were documented during the surveys (Table 3). Average percent cover varied by species, the most dominant species were millets (*E. walteri* and *E. muricata*) and smartweed (*Polygonum lapathifolium*) (Figure). Percent frequency of occurrence was highest for *Echinochloa walteri* (16.7%), followed by *Polygonum lapathifolium* (14.6%) and *Aster* sp. (14.6%) (Figure). Overall, the sampled portion of Pool 26, contained a relatively high species diversity (Figure). Of the 203 sites sampled, only 46 contained vegetation. When setting parameters for plot location a maximum depth of 8.2 feet (2.5 meters) below full pool (419 ft) was selected. This was done to capture anything that would be within the area exposed at max drawdown elevation (412.5 ft). However, since Pool 26 was in flood until the end of May and EPM levels were not achieved until early June, many of the areas within the area between 416 ft and 410.8 ft would have been underwater at the time of the surveys (Figure 4).

2.3 Integrated Waterbird Management and Monitoring Vegetation Surveys

2.3.1 Methods

Sites as described in Section 2.1 were surveyed in August 2018 to assess individual emergent plant species cover in Pools 26, 25, and 24. The Integrated Waterbird Management and Monitoring protocol was utilized to assess species abundance and percent cover (USFWS 2015). Only emergent vegetation from the current growing season was assessed. To complete the vegetation surveys while adhering to the protocol, two major steps were completed: 1) an assessment of percent cover of emergent vegetation within the survey unit was completed and 2) a species inventory and species-specific percent cover assessment within the areas of emergent vegetation were completed.

To complete the first step, the location of all emergent vegetation areas within each survey unit were determined. This was done by a visual assessment throughout each survey unit. Once all areas of emergent vegetation were identified, an estimate of the percent cover of the survey unit by emergent vegetation was completed. Percent cover is defined as the percentage of the survey unit covered by vertical projections from the outermost perimeter of the plants' foliage (Anderson 1986).

To complete the second step, a list of all common emergent vegetation species was compiled and an estimate of each species' percent cover was completed. For this estimate, percent cover is defined as above except that it is estimated as a percentage of emergent vegetation area, not as a percentage of the total survey unit area. For example, a survey unit could only contain a single species, Species X across 50% of the total survey unit area, but as an individual plant species it could cover 100% of the emergent vegetation area within the survey unit. So, 100% would be recorded for this measurement. Total cover across species can exceed 100% due to the stratification of plant species with varying heights and growth forms.

In addition to the two above measurements taken at each site, a qualitative estimate of seed head size and density was completed for each common emergent plant species. Seed head sizes were assigned a size of average, smaller, or larger than the average size for each species as compared to diagrams provided by this protocol. For seed head densities, the density of stems for a species and proportion of as species' stems with seed heads were assessed. Densities were assigned as low, moderate, or high. Low densities were characterized by large areas of bare ground and low proportion of seed heads to plant stems. High seed head densities were characterized by areas with little bare ground and a high proportion of seed heads to stems. Moderate seed head densities fall between the two aforementioned categories.

Mean percent cover was calculated by pool to compare species composition and densities between pools. Mean percent cover during IWMM surveys was calculated by site. Species percent frequency of occurrence for was calculated by pool. Species richness was calculated by pool. Simpson's diversity indices were calculated for Pools 26, 25, and 24. Simpson's evenness was calculated for Pools 26, 25, and 24. All species encountered throughout the IWMM and LTRM surveys were recorded and are displayed in Table .

2.3.2 Results

Table 4. Table of all species encountered during vegetation surveys.

Species Code	**Latin Name**	**Common Name**
AMCO	*Ammonia coccinea*	Valley redstem
AMSP	*Amaranthus spp.*	Pigweed spp.
ASSP	*Aster spp.*	Daisy spp.
ARAN	*Artemisia annua*	Annual wormwood
BISP	*Bidens spp.*	Beggarticks
BOFL	*Bolboschoenus fluviatilis*	River bulrush
CASP	*Carex spp.*	Sedge spp.
CYES	*Cyperus esculenta*	Yellow nutsedge
CYSP	*Cyperus spp.*	Flatsedge spp.
ECCR	*Echinochloa crusgalli*	Barnyard grass
ECES	*Echinochloa esculenta*	Japanese millet
ECPR	*Eclipta prostrata*	False daisy
ECWA	*Echinochloa walteri*	Walter's millet
ELSP	*Eleocharis spp.*	Spikerush spp.
ERHY	*Eragrostis hypnoides*	Teal lovegrass
EUPE	*Eupatorium spp.*	Thoroughwort spp.
HUJA	*Humulus japonicus*	Japanese hops
LEOR	*Leersia oryzoides*	Rice cutgrass
LEPA	*Leptochloa panicoides*	Amazon sprangletop
LIDU	*Lindernia dubia*	Yellowseed false pimpernel
LIMI	*Limna minor*	Duckweed
LUSP	*Ludwigia spp.*	Water primrose spp.
LYER	*Lycopus americana*	American bugleweed
MIRI	*Mimulus ringens*	Monkeyflower
NELU	*Nelumbo lutea*	American lotus
PADI	*Panicum dichotomiflorum*	Fall panicum
PASP	*Panicum spp.*	Panicum spp.
PEDI	*Pentharum sedoites*	Ditch stonecrop
PHLA	*Phyla lanceolata*	Lanceleaf frogfruit
POLA	*Polygonum lapathifolium*	Curlytop smartweed
POPE	*Polygonum pensylvanicum*	Pennsylvania smartweed
RUSP	*Rumex spp.*	Dock spp.
SALA	*Sagittaria latifolia*	Broadleaf arrowhead
SANI	*Salix nigra*	Black willow
SASP	*Sagittaria spp.*	Arrowhead spp.
SYLA	*Symphyotrichum lanceolatum*	White panicle aster
SYPR	*Symphyotrichum praealtum*	Willowleaf aster
VEHA	*Verbena hastata*	Swamp verbena
XASP	*Xanthium spp.*	Cocklebur spp.

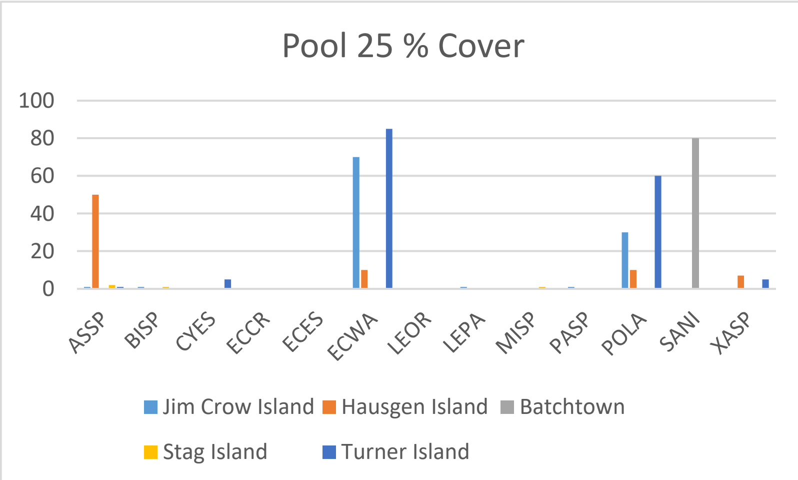

Figure 10. Pool 25 average percent cover by species and site during IWMM surveys.

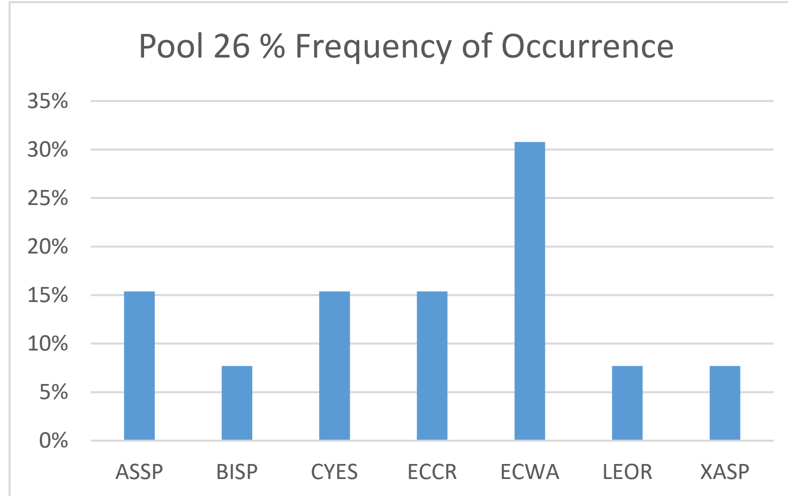

Figure 11. Pool 26 species percent frequency of occurrence for IWMM surveys.

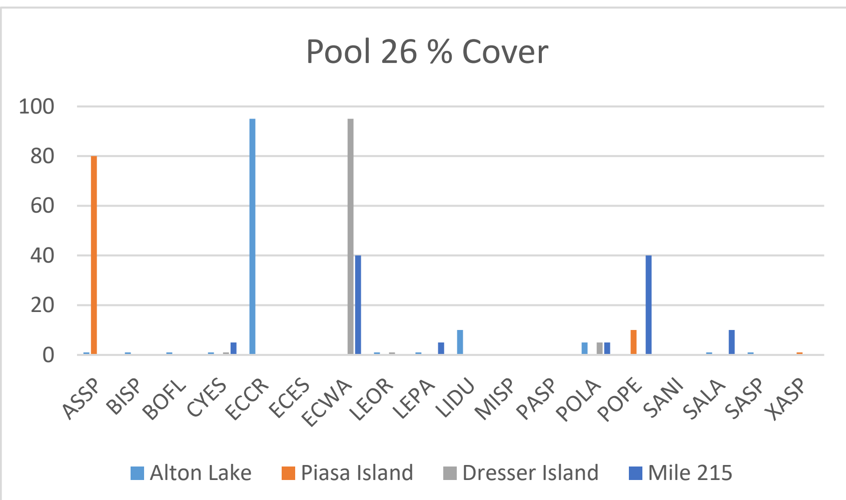

Figure 13. Pool 26 average percent cover by species and site during IWMM surveys.

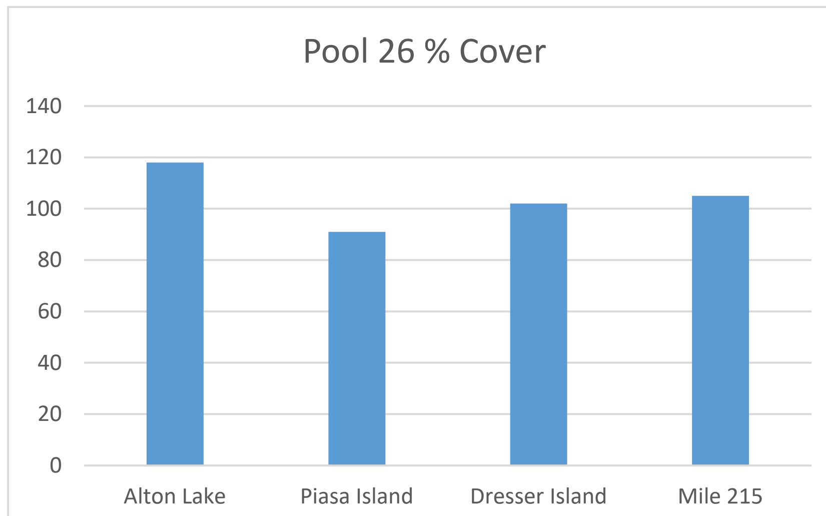

Figure 12. Pool 26 average percent cover by site during IWMM surveys.

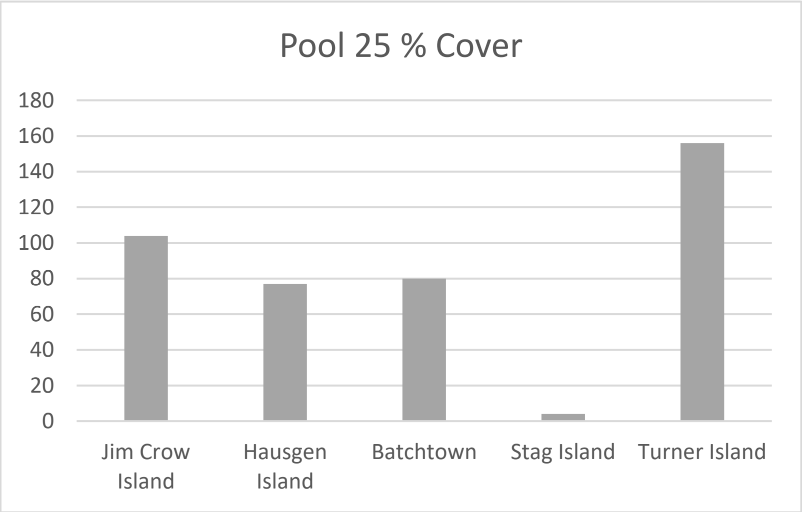

Figure 20. Pool 25 average percent cover by site during IWMM surveys.

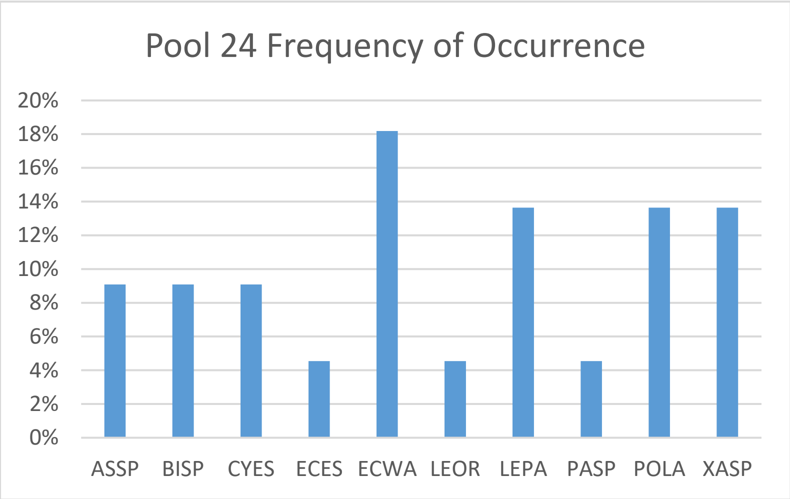

Figure 14. Pool 24 species percent frequency of occurrence for IWMM surveys.

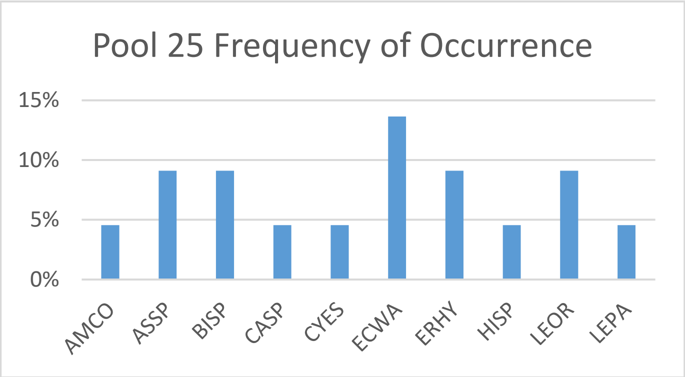

Figure 15. Pool 25 species percent frequency of occurrence for IWMM surveys.

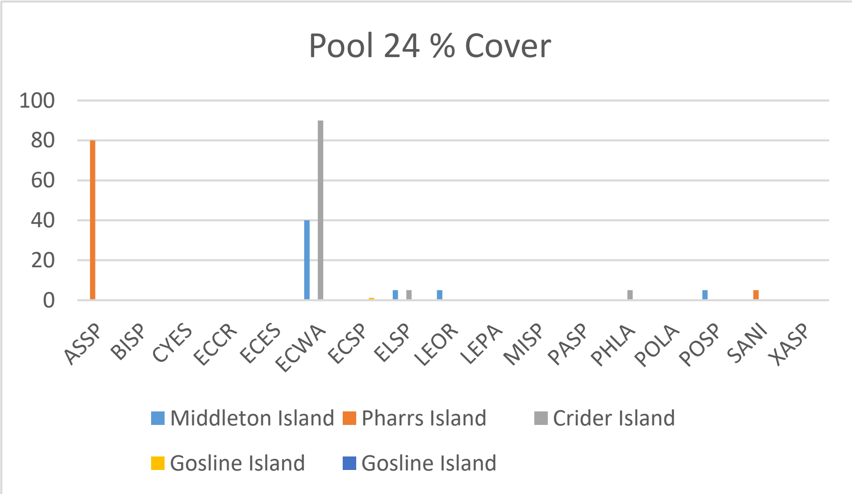

Figure 16. Pool 24 average percent cover by species and site during IWMM surveys.

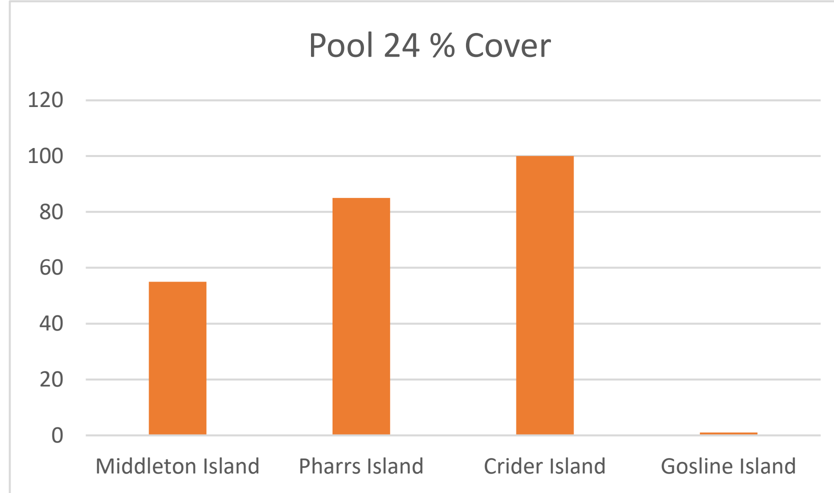

Figure 17. Pool 24 average percent cover by site during IWMM surveys.

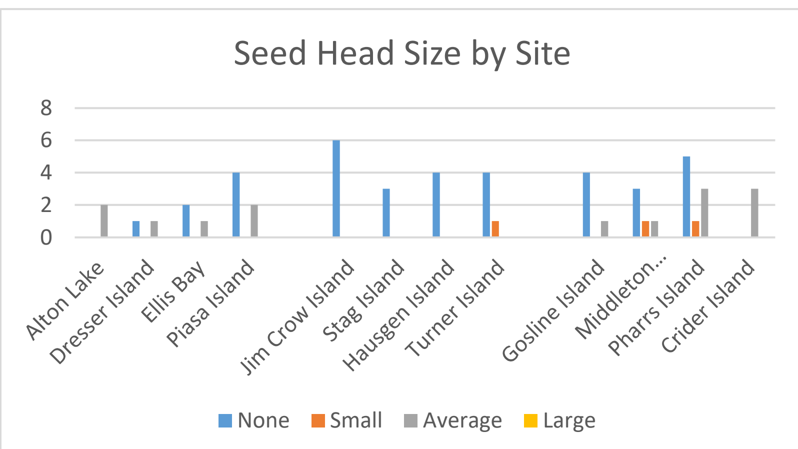

Figure 18. Count of species with seed heads by site. Average seed head size categorized as none, small, average, or large by species.

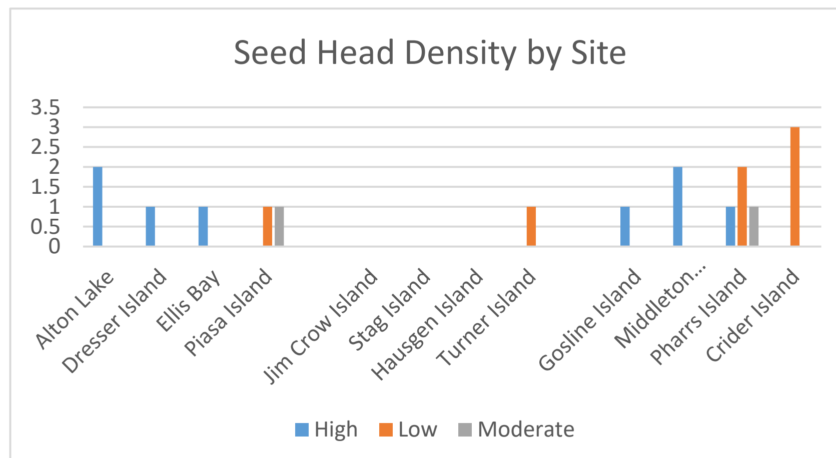

Figure 19. Count of seed head density by site. Average seed head density categorized as low, moderate, or high by species.

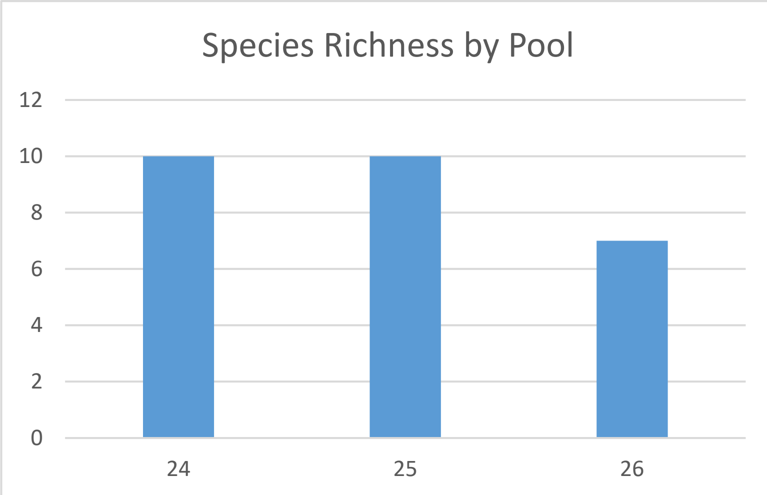

Figure 20. Species richness by pool.

2.3.3 Discussion

Average percent species cover varied by site and by pool. In Pool 26, *Echinochloa walteri* and *Polygonum lapathifolium* had the highest percent frequency of occurrence (Figure). Average percent cover varied by site, with Alton Lake having the highest percent cover (Figure) dominated by *Echinochloa crusgalli* (Figure 18). As noted in Section 2.2, percent cover is determined for areas with emergent vegetation present (Figures 27 and 28). At each site, areas were present without vegetation, which is dependent on ground elevations and water level fluctuations.

In Pool 25, growth was limited due to the late timing of when water receded from high flows previously in the season. Species percent cover varied by site (Figure 20). Sites were mixed (Figure 15) and *Echinochloa walterii* was observed most frequently (Figure).

In Pool 24, similar growth was seen due to timing of water recession. *Echinochloa walterii* was most commonly observed (Figure). Crider Island had the highest percent cover (Figure 23) dominated by *Echinochloa walterii* (Figure 22).

Figure 22. Stag Island (Pool 25), August 17, 2018. Photo by Ben McGuire, USFWS, formerly USACE.

Figure 21. Middleton Island (Pool 25), August 14, 2018. Photo by Ben McGuire, USFWS, formerly USACE.

2.4 Seed Head Analysis

2.4.1 Methods

In order to quantify the amount of seed produced from emergent aquatic plant species, a seed analysis was conducted. A qualitative assessment of species with seed heads and their density is provided in Figures 24 and 25. In previous years, three sites including Middleton Island in Pool 24, Jim Crow Island in Pool 25, and Alton Lake in Pool 26, were used as representatives for quantitative seed analysis each pool. However, high flows during the 2018 growing season limited the amount of seed producing emergent species in Pools 24 and 25. So only Pool 26 was sampled utilizing quantitative seed analysis methodology.

Sampling occurred when the majority of the plants had produced seed heads and before shattering. To accomplish the seed head analysis, randomly placed 1 m^2 plots were established at each site (Figure 29). Within each plot, the number of seed-producing plant stems were counted. Only the seven species that currently have a model built for seed production were counted, following Gray *et al* 2009. These species include: flatsedge (*Cyperus erythrorhizos*), barnyard grass (*Echinochloa crusgalli*), Walter's millet (*E. walteri*), Amazon sprangletop (*Leptochloa panicoides*), rice cutgrass (*Leersia oryzoides*), fall panicum (*Panicum dichotomiflorum*), and curlytop smartweed (*Polygonum lapathifolium*). One randomly selected plant stem specimen from each species was collected from each plant. In cases with multiple seed heads per stem, all seed heads were collected. Once seed heads were collected, they were placed into plastic bags while in the field. Upon returning from the field, the bags were opened and a fan was placed on them for drying. Drying was necessary to prevent mold from growing on the collected seed heads between sampling and during shipping of the specimens. Samples were sent to University of Tennessee, Knoxville for analysis utilizing Gray *et al* 2009 approach to quantify kilograms of dry seed produced per hectare, duck-energy-days (Kaminski *et al* 2003), total kilograms of seed produced per site, and total duck energy days (DEDs) per site.

Figure 23. Vegetation survey plot (1 m^2) for seed head surveys, Alton Lake, Pool 26. Photo by Ben McGuire, USFWS, formerly USACE.

2.4.2 Results

Duck energy-day estimates are provided in Appendix A. Seed production per acre improved from 2016 and 2017 for the site sampled. Seed production rates higher than 1,322.8 lbs/ac are considered highly productive for moist soil units (Dugger & Feddersen 2009). Alton Lake greatly exceeded this value, producing an average of 8,225.4 lbs/acre.

2.4.3 Discussion

The results in section 2.4.2 show a high seed production yield as compared to other wetlands which used the same quantification approach (Dugger & Feddersen 2009). The mean seed production rates of 8,225.4 lbs/acre in Pool 26 respectively are higher than average sampled moist-soil unit sites (Dugger & Fedderssen 2009). Since the plots were randomly placed within each of the sampled sites, areas which did not have vegetation, i.e., bare earth were sampled. Therefore, these calculations are conservative and do not necessarily represent the seed per acre produced within vegetated areas. Further, since the random plots within these sites captured a diversity of conditions within each site, these results can be extrapolated and applied to the area of influence for EPM for Pool 26 seed production in 2018. Using this method, Pool 26 (Figure 30), 1008.76 acres of vegetation produced 8,297,454 pounds of seed. When translated to Duck Energy Days (DEDs), Pool 26 could sustain the metabolic requirements of 3,415,762 ducks for one day or 56,929 ducks for 60 days.

Figure 30. *Echinochloa walteri* seed dropped at Alton Lake, Pool 26. Photo by Ben McGuire, USFWS, formerly USACE.

2.5 Transect Vegetation Surveys

2.5.1 Methods

Following the Illinois Natural History Survey, Critical Trends Assessment Protocol for Wetland sites (INHS 2002), a transect is placed perpendicular to the long length of the wetland. A random a distance along the transect is selected. This baseline is placed along the edge of the wetland vegetation and parallel to the long dimension of the wetland. When lying the transect, the tape measure is pulled taut, but laid upon the ground at all points along its length (Figure 31). Herbaceous vegetation is sampled in ¼ m^2 quadrats at an interval of every 2m along the transect, starting 2m from the baseline. A total of 20 quadrats are sampled per

Figure 24. Transect vegetation survey plot (1/4 m^2), Piasa Island, Pool 26. Photo by Ben McGuire, USFWS, formerly USACE.

site. Quadrats are placed 1m from the transect on alternate sides, starting on the left at the 2m point (e.g. the first quadrat covers the area from 2-2.5 m along the transect, at a distance covering 1-1.5 m left of the transect). In Pool 26, Mile 210 Area, Dresser Island Conservation Area, and Alton Lake were sampled (Figure 32).

2.5.2 Results

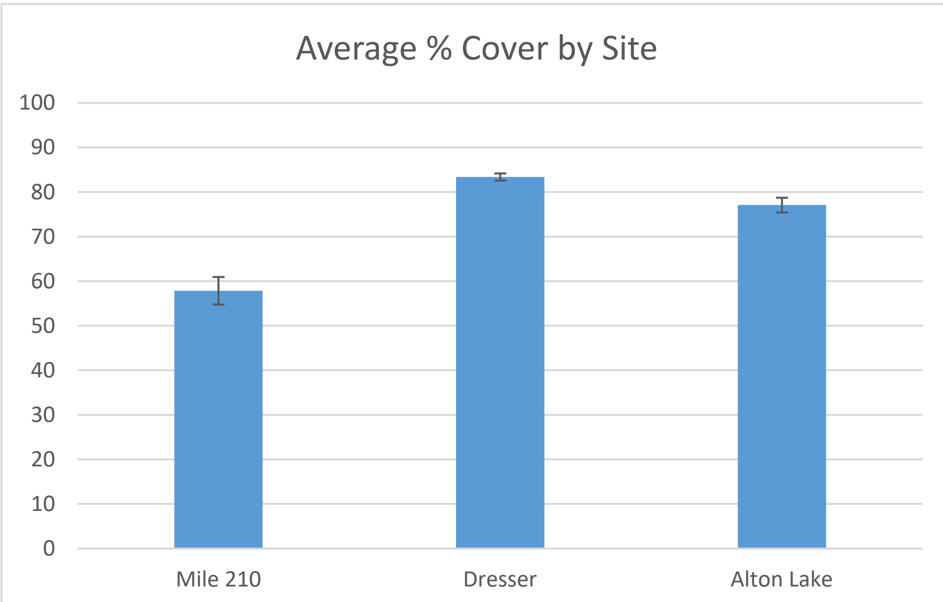

Figure 25. Average percent cover by site.

2.5.3 Discussion

Results for the transect surveys were similar to that of the IWMM surveys (Section 2.2) in that sites sampled in Pool 26, millet (*Echinochloa* spp.) species were most common. The higher presence of millet throughout the sites within each pool can likely be attributed to the later time in which these sites were dried and maintained suitable soil temperatures for the germination of emergent aquatic plants (Yoshioka *et al* 1998).

Chapter 3 Additional Results

3.1 Vegetation

In Pool 26, arrowhead (Sagittaria latifolia) was also observed in several locations throughout the surveyed sites (Figure). One site in particular, Mile 210 Area, had a large density of arrowhead (Figure 33). These species were documented within this area of Pool 26 historically (Reese and Lubinski 1983) but more recently have not been observed. The longer water level reduction time during 2016 likely restored conditions in which American lotus and arrowhead could germinate and continue their growth in 2017 and 2018. These species have seeds that are viable for long periods of time. With continued longer duration water level reductions, these species would likely continue to germinate, build below-ground resources, and possibly persist if given multiple seasons to do so. In addition, the consolidated sediment observed in this site and others would improve establishment conditions for these plants as well as submersed aquatic plants.

Figure 26. Arrowhead (*Sagittaria latifolia*) at Alton Lake, Pool 26, 2016. Photo by Ben McGuire, USFWS, formerly USACE.

Figure 27. Arrowhead beds along shoreline, Mile 210 Area, Pool 26. Photo by Ben McGuire, USFWS, formerly USACE.

3.2 Decurrent False Aster (*Boltonia decurrens*)

Boltonia decurrens, a federally threatened species was documented in Ellis Bat in lower Pool 26 (Figure 35). This species is a disturbance species which will colonize on exposed mudflat areas following flood events.

Figure 28. *Boltonia decurrens* in Ellis Bay, lower Pool 26. Photo by Ben McGuire, USFWS, formerly USACE.

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Appendix A – Pool 26 Seed Yield and Duck Energy-day Estimates, September 2018

Summary

Benjamin McGuire submitted unpressed seed heads to the University of Tennessee Wetlands Program for seed production and duck energy-day (DED) estimates that were collected randomly from twelve 1-m^2 plots in moist-soil wetlands at one site (Alton Lake) located near the Mississippi River in Missouri. Seed heads were pressed for one week, seed-head area for each plant was scanned, and seed-head area (cm^2) estimates used to predict dry seed mass (g) per plant using models in Gray et al. (2009). Plant species that were collected included yellow nutsedge (*Cyperus esculentus*), sprangeltop (*Leptochloa panicoides*), Walter's millet (*Echinochloa walteri*), rice cutgrass (*Leersia oryzoides*), and nodding smartweed (*Polygonum lapathifolium*). Seed production/plant was multiplied by plant density/m^2 for each species, seed production was summed across species within a plot, and estimates were converted to kg/ha and lbs/ac. Duck energy-day estimates were calculated using seed production, true metabolizable energy of seed, and the daily energy requirement of mallards (Gray et al. 2013). Details on methods are available at http://fwf.ag.utk.edu/mgray/DED/DED.htm. Seed production and DED estimates were averaged among plots, and the standard deviation and 95% confidence intervals were calculated.

The seed production at the Alton Lake site ranged from 0 - 2651 kg/ha (0 - 22,941 lbs/ac, Table A1). Average seed production among plots was 960.1 kg/ha (8,225.4 lbs/ac; Table A1) and could be classified as high seed yield (see reference values below). However, seed production was highly variable spatially, with plots 1 – 6 producing low amounts of seed and plots 7 – 12 producing abundant seed (Table A1).

<u>Seed Production Reference Values</u>[1]

- <200 kg/ha = low production
- 200-600 kg/ha = moderate production
- >600 kg/ha = high production

[1]Based on moist-soil production estimates provided in Gray et al. (1999) and Kross et al. (2008).

Based on the plant species present and seed production in plots 7 – 12, the moist-soil wetlands in those locations could be classified as early successional, and disturbance to set back succession (e.g., disking) probably isn't necessary. However, low to nonexistent seed production in plots 1 – 6 suggest management is necessary in those locations. Mechanical manipulations (e.g., disking), herbicide application of invasive plants, and supplemental planting of an agricultural variety of a moist-soil plant species (e.g., Japanese millet, *E. esculenta*) in 2019 could help improve seed production in areas near plots with low seed production. Moderate application of fertilizer also can improve seed production in moist-soil wetlands (Gray et al. 2013).

Duck energy-day estimates is provided (Table A1). Total estimated DEDs for the Alton Lake site (84.984 ha, 210 ac) was 795,343 DEDs, which is equivalent to having the energetic potential to support **7,230 ducks per day for 110 days**.

Table A1. Seed production and duck energy-days (DED) estimated from 12 plots in moist-soil wetlands at Alton Lake, September 2018.

Plot	kg/ha	DED/ha	lbs/ac	DED/ac
1	0	0	0	0
2	9.64	94.42	84.24	34.09
3	0	0	0	0
4	28.785	274.395411	25.6814013	111.0478228
5	404.28	3940.42	3499.77	1423.71
6	0	0	0	0
7	1424.11	13763.63	11760.81	4998.75
8	1977.99	19282.32	16633.20	6993.68
9	2651.60	25819.09	22941.14	9328.26
10	2317.56	22692.98	20240.96	8193.97
11	1580.54	15480.67	13811.54	5589.53
12	1127.24	10957.02	9707.18	3960.34
Mean	960.1	9358.7	8225.4	3386.1
Median	765.8	7448.7	6603.5	2692.0
Lower 95% CI	388.9	3785.9	3291.8	1371.7
Upper 95% CI	1531.4	17992.2	15868.4	6506.9
SD	1009.6	9849.4	8719.5	3560.3

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