

Sustainable Rivers Program

Environmental Pool Management -
Implementation Potential and associated
Vegetation Monitoring Protocols for the
Upper Mississippi River



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June 2024

Above: Emergent vegetation at Alton Lake in Pool 26 (USACE photo).

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1. Introduction

Water level management (WLM) or environmental pool management (EPM) is an ecosystem restoration tool utilized in the Upper Mississippi River (UMR). The goal of WLM is to promote development of vegetated wetland habitat in lock and dam navigation pools, while maintaining a safe and dependable navigation channel. WLM has been shown to improve ecosystem function and health as well as provide additional habitat for fish and wildlife. The tool has been utilized and implemented for over 25 years in portions of the UMR.

The locks and dams on the Upper Mississippi River were authorized for navigation in 1930. The U.S. Army Corps of Engineers (USACE) operates the locks and dams on the Mississippi River for navigation, not flood control. There are 27 lock and dam reservoirs on the UMR (4 MVS, 12 MVR, and 11 MVP). Established partnerships between three USACE districts on the UMR, state and federal natural resource agencies, non-governmental conservation organizations, and the public have allowed productive communications and on-the-ground implementation of environmental projects such as WLM.

The work documented in this report was done to help inform potential WLM efforts in MVR and MVP by evaluating capacity for small scale WLM at the 23 uppermost pools, quantifying potential environmental acreage that could be improved. The effort builds upon Planning Assistance to the States efforts sponsored by the Upper Mississippi River Basin Association, representing the five states in the Upper Mississippi River: Illinois, Missouri, Iowa, Wisconsin, and Minnesota. The work was multidisciplinary as it involved staff from Water Control in the three districts, Hydrologic and Hydraulic engineering (H&H) in MVR and MVP, and Planning in MVP and MVS. To advance WLM in MVS, a new vegetation monitoring method to evaluate plant response was initiated and investigations were done to improve understanding of native vegetation dynamics. Over 500 miles of water level management potential on the Upper Mississippi River were assessed.

Overall, work for the Upper Mississippi River fell into 4 categories:

- Analyze 2016-2018 growing season (May 1- Sept 30) gage data from UMR locks and dams for capability of small-scale water level management. Analyses incorporated current operating band constraints to assess ability to reduce cost of implementation and conduct WLM actions without a need for additional coordination and assessments of impacts. This will be provided as a separate report.
- Quantify acres exposed for water level management at elevations 0.5 feet (ft), 1.0 ft, 1.5 ft and 2.0 ft below normal pool elevation in pools 2, 3, 5, 5a, 6, 7, 8, 9, and 10 in MVP and pools 12, 13, 16, 18, 19, 21, 22, and Starved Rock in MVR. Results of this effort will be made available as part of the NESP Report 53 update (WLM Regional Coordinating Committee, 2022). A summary of findings is presented in section 3.
- Acquire and deploy photo monitoring devices to evaluate vegetation response to water level management in Pools 24, 25, and 26 on the Mississippi River, create a time-lapse video for each monitoring site at the end of the growing season, and summarize methods, results, and findings (see Section 4)
- Native vegetation resilience study in Pool 26 through evaluation of arrowhead development post 2019 flood, development of an arrowhead tuber assessment protocol, and an assessment

of current vegetation conditions compared to historical annotated checklist of lower Pool 26 vegetation (Reese M. L., 1983) (see Section 5).

2. Assessment of drawdown success rate and acres exposed at multiple drawdown depths.

Several analyses were performed as part as the NESP Report 53 update and details on considerations, assumptions, methods, and analyses can be found there (WLM Regional Coordinating Committee, 2022). A summary of report results for the hydrologic success rate of drawdowns and acres exposed at 0.5, 1.0, 1.5, and 2.0 ft drawdowns in MVR and MVP managed pools are provided in sections 2.1 and 2.2.

2.1 Success rate analysis

Estimates of hydrologic success rate was analyzed by dam control method (i.e., hinge point, primary-secondary, tertiary, and dam point control) for MVR and MVP pools, including Starved Rock on the Illinois Waterway (IWW). Results are provided in tables 1 and 2. See the primary report (WLM Regional Coordinating Committee, 2022) for more information on methods, analysis, and discussion on average daily hydrologic success rate. An “optimal” event is a drawdown of 90 days or more at the specified pool reduction level within the growing season (May 15-September 15). A “minimum” criteria event is a drawdown that reduces pool level at the specified level for at least 80% of a 60-day period during the growing season.

Table 1. Estimated average daily rate of hydrologic success for drawdowns in selected pools of dams operated under hinge point and primary-secondary-tertiary control. Values are the percentage of years meeting the drawdown criteria, 1981-2019.

River	Pool	0.5 ft Drawdown		1.0 ft Drawdown		1.5 ft Drawdown		2.0 ft Drawdown	
		Optimal	Minimum	Optimal	Minimum	Optimal	Minimum	Optimal	Minimum
UMR	2	49%	85%	41%	85%	31%	74%	15%	54%
	3	28%	59%	5%	28%	0%	21%	0%	3%
	5	92%	97%	80%	95%	72%	85%	64%	85%
	5A	39%	62%	13%	33%	5%	18%	0%	5%
	6	51%	87%	44%	64%	31%	54%	21%	41%
	8	64%	92%	59%	90%	49%	80%	46%	67%
	9	18%	36%	23%	36%	0%	10%	0%	5%
	10	13%	33%	0%	21%	0%	3%	0%	0%
	16	62%	90%	46%	85%	33%	69%	23%	51%

Table 2. Estimated rate of hydrologic success for drawdowns in selected pools of dams operated under dam-point control. Values are the percentage of years meeting drawdown criteria, 1981-2019.

River	Pool	0.5 ft Drawdown		1.0 ft Drawdown		1.5 ft Drawdown		2.0 ft Drawdown	
		Optimal	Minimum	Optimal	Minimum	Optimal	Minimum	Optimal	Minimum
UMR	7	92%	100%	77%	97%	64%	92%	51%	87%
	11	92%	100%	92%	100%	90%	97%	90%	97%
	12	67%	87%	56%	87%	44%	80%	44%	77%
	13	90%	97%	90%	97%	87%	95%	77%	95%
	18	62%	92%	59%	90%	56%	90%	49%	82%
	19	100%	100%	100%	100%	100%	100%	100%	100%
	21	38%	74%	38%	74%	33%	69%	31%	64%
	22	46%	85%	41%	82%	38%	74%	38%	74%
IWW	Starved Rock	100%	100%	100%	100%	100%	100%	100%	100%

2.2 Acres exposed

To estimate the number of acres exposed by drawdowns (of varying magnitudes) in the selected pools, the existing CWMS Hydrologic Engineering Center River Analysis System (HEC-RAS) models and the USGS UMESC Topobathy (i.e., topography and bathymetry) datasets were used. Estimates of maximum potential number of acres exposed were analyzed by dam control method (i.e., hinge point, primary-secondary, tertiary, and dam point control) and the results are provided in the below tables. See the primary report for more information on methods, analysis, and discussion on maximum area exposed.

The results of the acres exposed analysis is shown in tables 3 and 4 below and separated by hinge point, primary-secondary-tertiary, and dam point control at dams in MVR and MVP districts. The combined acreage exposed for all listed pools at the 2 ft drawdown totals to 36,684 acres.

Table 3. Estimated acres exposed by alternative drawdowns for dams in selected pools of dams operated under hinge point and primary-secondary-tertiary control, based on the 1981-2019 period of record. Values are the maximum potential exposure under optimal flow conditions.

River	Pool	0.5 ft Drawdown	1.0 ft Drawdown	1.5 ft Drawdown	2.0 ft Drawdown
		Acres	Acres	Acres	Acres
UMR	2	1,014	1,167	1,867	1,976
	3	280	351	510	673
	5	382	606	827	1,204
	5A	399	981	1,408	2,328
	6	411	477	1,003	1,079
	8	968	1,538	2,082	2,740
	9	1,847	1,872	2,726	3,107
	10	1,244	1,607	2,015	2,499
	16	316	867	1,202	1,454

Table 4. Estimated acres exposed by alternative drawdowns for dams in selected pools of dams operated under dam-point control, based on the 1981-2019 period of record. Values are the maximum potential exposure under optimal flow conditions.

River	Pool	0.5 ft Drawdown	1.0 ft Drawdown	1.5 ft Drawdown	2.0 ft Drawdown
		Acres	Acres	Acres	Acres
UMR	7	64	1,124	1,678	2,110
	11	679	1,507	2,648	3,461
	12	679	1,241	1,632	1,992
	13	812	1,627	2,593	3,623
	18	508	978	1,420	2,153
	19	1,467	2,438	3,354	4,576
	21	188	366	520	679
	22	66	145	219	295
IWW	Starved Rock	208	395	584	735

3. Photo monitoring

The St. Louis District purchased and deployed eight trail cameras in environmental pool management (EPM) exposed areas during the summer of 2020 to help evaluate vegetation establishment in response to a growing season drawdown in each of the MVS managed pools. An additional goal of this effort was to produce a brief outreach video that would help illustrate the benefits of environmental pool management.

The St. Louis District used Bushnell Cameras (Model- Trophy Cam E3) programmed to take 6 pictures a day at maximum resolution (16 MP) to ensure several clear photos from each day could be extracted to create a time-lapse video. Placement of cameras was delayed until mid-June due to a late-spring flood that impacted the areas. Eight cameras were set up and placed in the Environmental Pool Management impacted areas of Pools 24, 25, and 26 of the Mississippi River (Figure 1-3). Sites were prioritized by their size, aspect, and likelihood of supporting emergent wetland vegetation. When possible, cameras were placed on the southern border of a backwater area and pointed north to reduce sun glare during daylight hours. Cameras were secured to trees approximately 10 feet above the maximum regulated pool level, and any small, crossing branches from neighboring trees were cleared from the device’s field of view to maximize emergent wetland area captured in time-lapse photos. Four cameras were placed in Pool 26, because it has the largest contiguous backwater areas impacted by EPM and has produced abundant emergent vegetation frequently since implementation began in the 1990’s. Two cameras each were placed in Pools 25 and 24. See table 5 for deployment start and end dates for the time lapse study. Camera recovery dates coincided with the last plant monitoring date in each of the pools that occurred during the 2020 growing season.



Figure 1. Pool 24 photo monitoring locations.



Figure 2. Pool 25 photo monitoring locations.



Figure 3. Pool 26 photo monitoring locations.

Table 5. Time-lapse photo station start and end dates during summer 2020.

Pool	Deployment Date	End Date
24	June 18	August 28
25	June 19	September 3
26	June 12	September 9

3.1 Methods

Time lapse videos were produced utilizing one of two programs. One method utilized powerpoint which provided the ability to build a brief video that could be edited and viewed utilizing existing software which is approved on all USACE devices. The other method utilized Corel VideoStudio Suite from a personal computer.

Powerpoint provided a simple method of building a time-lapse video of the vegetation response to exposure. Enough slides were added to the presentation to contain one image from each day the trail camera was deployed. Once all the images were added to the presentation, we selected the transitions tab and experimented with the duration that each slide would be visible before transitioning to the next slide in presentation mode. Setting the transition duration to 0.75 seconds allowed viewers to see differences in the images easily while also balancing the length of the video. Text boxes were added to slides that represented changing conditions in the images to insert relevant text for viewers. The advance slide duration was adjusted based on the length of text for just slides with text. We allocated approximately 2 seconds for each full line of text. The time lapse presentation was then saved with all edited slide transitions and can be opened on any device that has powerpoint. To create a version of

the video that could be played at a website location or uploaded to a video streaming platform a version of the Mile 210 the timelapse presentation was saved as a movie file (.mp4 format) utilizing the following steps. The time lapse sequence was played while recording the screen (function available in recording menu of powerpoint) which created the video on a separate slide. The length of the video was then trimmed in the playback menu so that only the time lapse video sequence was shown. The video could then be saved by right clicking on the video and save the file as a .mp4 file. Other videos were created without text and the duration between slide transitions was left at 0.5 seconds.

The second method utilized involved Corel VideoStudio Suite which was utilized from a personal computer which was disconnected from USACE networks. This was utilized because we were unaware of the function above in powerpoint and the Corel software was already installed. Other software that is preapproved for use on USACE computers would be preferable. The primary benefit of the Corel software was that uploading images into the video could be done as one batch rather than individually which created lags and program freezing in powerpoint. In the Corel software, the images load sequentially and then the video can be modified easily with a few short steps. Once uploaded a transition time between images could be applied to all in one step. Since text was not added to these videos, a shorter transition duration was selected.

3.2 Results

Time lapse videos were created for six of eight sites to illustrate stages of emergent community development throughout the growing season. The Alton Lake time-lapse video was representative of the plant response in all three pools so it was selected as the video to further develop for outreach efforts for educating the public about Environmental Pool Management in St. Louis. The Nature Conservancy provided the major editing to add in captions that describe plant community development and benefits. Coordination with USACE St. Louis District occurred throughout development though and was shared with the Sustainable Rivers Program for use. After addition of the text, the video could be disseminated through multiple channels including the district EPM site, the Sustainable Rivers Program site, and through District social media.

Pool 26

Alton Lake, Ellis Bay, Mile 210 and Piasa Island cameras all provided clear views of vegetation development in response to environmental pool management. The orientation of the camera at Piasa makes it difficult to illustrate the extent of growth as there is a narrow border on the north and south edge of the backwater at this location. The interior is deep enough to remain as open water throughout all pool fluctuations. Alton Lake and Ellis Bay both illustrate the fluctuations in water level and plant response to environmental pool management well. Alton Lake was developed into a video with text to explain the changes that occur during the growing season with environmental pool management. A time-lapse video with captions was also developed for the Mile 210 area utilizing the powerpoint method described earlier.

Pool 25

Cameras were placed at both Turner and Jim Crow Islands. Resprouting occurred from trimmed branches near the camera on Turner Island and obscured the field of view for a significant portion of the environmental pool management period. As a result, only the images from Jim Crow Island were usable for compiling a time-lapse video. Jim Crow Island has an exterior ridge at the connection with the

channel and is buffered from small fluctuations in river elevations. The images could be used for informational purposes at meetings but is not representative of most areas affected by environmental pool management due to the ridge that has developed. As a result, a simple time series video without captions was created for discussions with groups but not further developed.

Pool 24

A time lapse video of Pharris Island without captions was created to share at local public meetings. The time lapse video from this location illustrates plant response to several fluctuations in water early in the season, and then the flush of germination that occurred once water elevations were stable for a couple weeks during summer. In addition, the time lapse shows how the emergent vegetation tolerates shallow flooding for an extended period of time once the plants are out of the seedling stage of growth. A time lapse video for Middleton was generated but is less ideal due to Sycamore (*Platanus occidentalis*) resprouting that occurred and covered up much of the field of view later in the season as emergent vegetation was filling in exposed areas. The location of this camera was placed just outside the entrance to the island as much of the interior had been colonized by Willow (*Salix* spp.).

4. Native vegetation resilience study in Pool 26

The vegetation resilience assessment in Pool 26 aimed to evaluate survival of arrowhead that had established prior to the 2019 flood by conducting transects at the end of the 2020 growing season. In addition, development of an arrowhead corm (tuber) sampling protocol occurred to find a suitable method of assessing tuber production in arrowhead. Lastly a comparison of current vegetation exposed during EPM to a 1980s survey of floodplain vegetation communities was performed for shallow wetland habitats.

4.1 Protocol development

During FY20, the MVS district worked with ERDC to develop an arrowhead (*Sagittaria*) tuber sampling protocol at the Mile 210 area. The process started with a literature search of other similar sampling methods and resulted in consideration of two sampling methods. Both methods were acceptable for sampling corms but varied in the cost to implement and the total volume of sediment extracted from the quadrat area.

The first study found was developed to evaluate vegetation response to Pool 8 drawdowns and used the following procedure (personal communications, Kevin Kenow, 2020):

1. Collect 3 benthic cores within quadrat using a copper tube core sampler. The core sampler consists of a 7.58 cm inside diameter copper tube that is 1 m in length. A 1 meter (m) handle consisting of 6.08 (outside diameter) centimeter (cm) pipe is attached to the copper tube to facilitate use of the core sampler in deep (> 1 m) water. Collect the 3 cores to a minimum depth of 45 cm from within the 0.25-m² quadrat area.
2. Place each core sample (subsample) in a separate plastic bag along with a label that contains study number, study area, sample site number, quadrat number, subsample designation A-C, date, and initials of collector. Core samples will be stored outside, in the shade, for a maximum of 7 days until processed.

3. Wash contents of core samples through a US No. 10 screen with water. All corms and winter buds will be placed in plastic containers with labels described in step 3 above. Care will be taken to remove all residual mud, stems, and other debris from the corms before drying.
4. Store corms in a walk-in freezer or chest freezer until they can be processed.
5. Wash composite core samples which contained arrowhead plants with water through a 2.0 mm mesh sieve. Collect all *Sagittaria* corms and tuber pieces. After washing, measure length and width of all whole corms to the nearest 0.01 mm using digital calipers. Tuber (and tuber pieces) were then dried at 50°C to a constant weight and weighed to the nearest 0.0001 g.

The second study (Clark & Clay, 1985) utilized the following procedure in Pool 9:

1. Establish transect locations and randomly select points to sample arrowhead.
2. Harvest and weigh all live material of arrowhead plants within 1 m² quadrat. Material was brought back to the lab, dried for 48 hours at 80°C and reweighed.
3. Belowground standing crop of arrowhead was measured in the same quadrats as the aboveground material. A 0.5 m³ area was excavated within the quadrat. Live plant fragments were separated from the soil by hand washing. Belowground material was weighed and dried at 80°C for 96 to 158 hours (until powdery dry) and reweighed.

We selected the method described in Clark and Clay (1985) due to its ease of replicability at other locations as it just required a tool to excavate sediment and a measured quadrat. In comparison, the protocol shared by Kenow would require purchase of a copper tube core sampler suitable for extraction of fine sediments in backwater areas that may or may not be inundated at the time of extraction. We anticipated challenges extracting intact cores due to previous experience extracting 1-m cores from similar lake areas in the region. We would make a couple modifications to the Clark and Clay method to adapt to conditions at our site. The first change is that the aboveground and belowground samples would both be taken from a square with 0.5-m sides. The second change involved separate measurements and weights of aboveground and belowground plant matter (i.e., leaves, shoots, and roots). Arrowhead is reestablishing after the flood of 2019. Handling aboveground and belowground plant matter separately would better support consideration of plants that are in various stages of development (juvenile and adult plants). Finally, to dry samples, we would use a heating mat (approximately 40°C) to dry plant material until powdery dry and then store in a sealed container with silica desiccant. Sample drying would continue until sample weights remain unchanged.

Overall, this is a sampling method that could be implemented with minimal equipment requirements while still assessing development of arrowhead corms.

4.2 Long Term Resource Monitoring vegetation surveys

4.2.1 Methods

The lower half (RM 201-221) of Pool 26 was sampled using the Long-Term Resource Monitoring (LTRM) Vegetation Survey Protocol (Yin, Winkelmann, & Langrehr, 2000). Within each site, plot locations were determined using the LTRM Stratified Random Sampling design, where a 50 x 50-m grid is generated and

overlaid onto a map. Nodes of the grid are geospatially registered with coordinates generated. Nodes that fall within the sites and 1.5 m or less 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 4). 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 = 61-80%; 5 = 81-100%. A cover rating was assigned to each species within each subplot.

LTRM Survey Point Locations 2020-2021

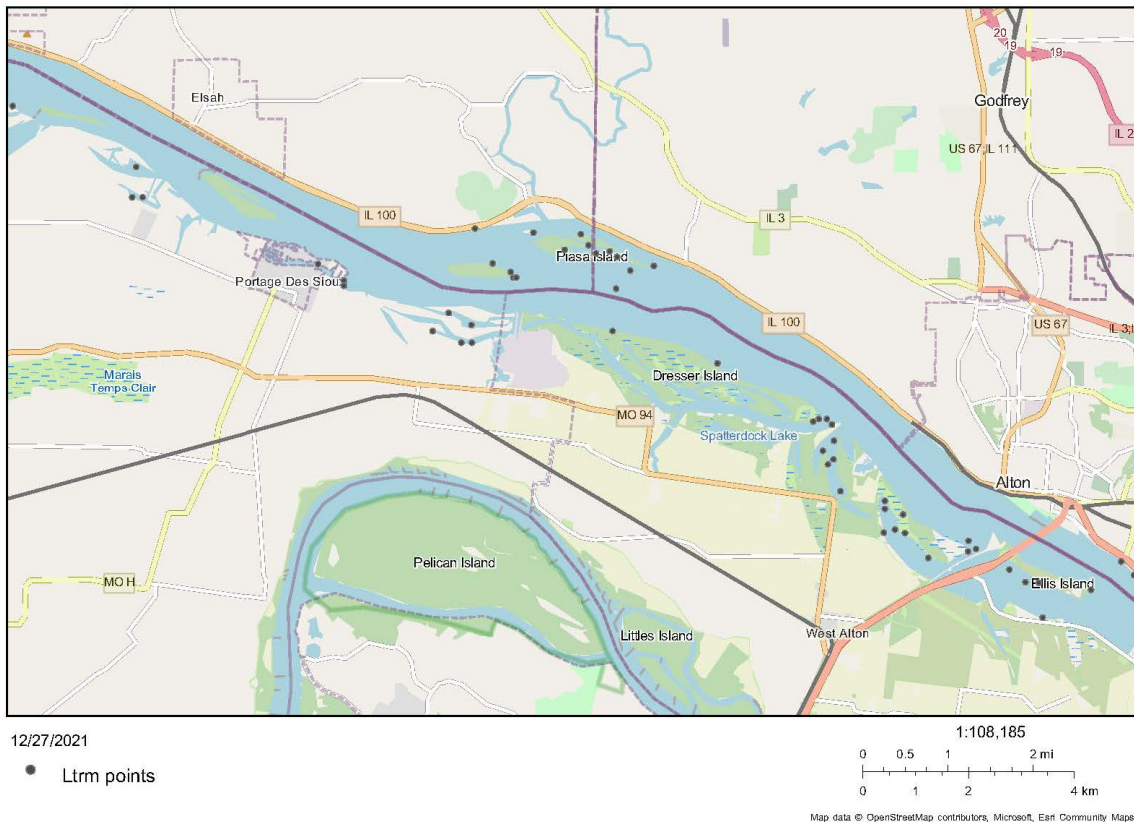


Figure 4. LTRM aquatic vegetation sampling locations.

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, percent frequency of occurrence, and species richness were calculated.

4.2.2 Results

29 species were recorded during the 2020 surveys (Table 6). Early season flooding delayed exposure of sediments and created conditions that supported a mixture of species that germinate at higher rates in

the mid- and early growing seasons. The later drawdown produced a more diverse assemblage of dominant plant species than years with an early drawdown. Percent cover class values were highest for yellow nutsedge (*Cyperus esculentus*) followed by millets (*Echinochloa* spp.), nodding smartweed (*Polygonum lapathifolium*), and sprangletop (*Leptochloa panicoides*) (Figure 5). Yellow nutsedge and sprangletop had the greatest frequency of occurrence values followed by nodding smartweed and Walter’s millet (Figure 6). These results are typical of a later drawdown that produces two or more layers of emergent vegetation. The lower layer is often comprised of teal lovegrass, nutsedge, sprangletop and an assortment of low-growing forbs such as scarlet toothcup (*Ammania coccinea*), false pimpernel (*Lindernia dubia*), and *Bidens* spp. among others. The middle and upper layer is typically comprised of taller species such as smartweeds, millets, and rice cutgrass. Arrowhead had a low plant coverage class value (Figure 5; see SALA2) and frequency of occurrence (6.7%) at vegetated plots (Figure 6).

Table 6. Codes for species recorded during Long-Term Resource Monitoring (LTRM) or Critical Trends Assessment Protocol (CTAP) sampling events.

Code	Scientific Name	Common Name	LTRM	CTAP
ABTH	<i>Abutilon theophrastii</i>	velvetleaf	X	
ACSA2	<i>Acer saccharinum</i>	silver maple	X	X
AMCO	<i>Ammania coccinea</i>	scarlet toothcup	X	X
AMSP	<i>Ameranthus</i> sp.	<i>Ameranthus</i> species		X
AMTU	<i>Ameranthus tuberculatus</i>	water hemp	X	
BARO	<i>Bacopa rotundifolia</i>	roundleaf water hyssop	X	X
BICE	<i>Bidens cernua</i>	nodding marigold	X	
BISP	<i>Bidens</i> sp.	beggar-ticks species	X	X
CEOC	<i>Cephalanthus occidentalis</i>	buttonbush		X
CHFA	<i>Chamaecrista fasciculata</i>	partridge pea	X	
COER	<i>Commelina erecta</i>	whitemouth dayflower	X	
CYES	<i>Cyperus esculentus</i>	yellow nutsedge	X	X
CYER	<i>Cyperus erythrorhizos</i>	redroot flatsedge	X	
ECCR	<i>Echinochloa crus-galli</i>	millet	X	X
ECMU	<i>Echinochloa muricata</i>	rough barnyard grass	X	X
ECWA	<i>Echinochloa walteri</i>	walter's millet	X	X
ECPR	<i>Eclipta prostrata</i>	yerba de tajo	X	X
ELOCH	<i>Eleocharis</i> sp.	spikerushes	X	
ERHY	<i>Eragrostis hypnoides</i>	teal lovegrass	X	
HELI2	<i>Heteranthera limosa</i>	blue mud plantain	X	
IPLA	<i>Ipomoea lacunosa</i>	small white-flower morning glory	X	X
LEOR	<i>Leersia oryzoides</i>	rice cutgrass	X	X
LEPA3	<i>Leptachloa panicoides</i>	Amazon sprangletop	X	X
LIDU	<i>Lindernia dubia</i>	false pimpernel	X	X
LOSI	<i>Lobelia siphilitica</i>	blue lobelia	X	

LUPE5	<i>Ludwigia peploides</i>	water primrose	X	
NELU	<i>Nelumbo lutea</i>	American lotus	X	
PADI	<i>Panicum dichotiflorum</i>	fall panic grass	X	
PASP	<i>Panicum sp.</i>	<i>Panicum</i> species		X
PHLA3	<i>Phyla lanceolata</i>	frog-fruit	X	
POLA4	<i>Polygonum lapathifolium</i>	curlytop smartweed	X	X
POPE2	<i>Polygonum pennsylvanicum</i>	Pennsylvania smartweed	X	
POSP	<i>Polygonum sp.</i>	smartweed species		X
PODE3	<i>Populus deltoides</i>	eastern cottonwood	X	X
ROSE	<i>Rorippa sessiflora</i>	sessile-flowered cress	X	
RUCR	<i>Rumex crispus</i>	curly dock	X	
SALA2	<i>Sagittaria latifolia</i>	broadleaf arrowhead	X	X
SANI	<i>Salix nigra</i>	black willow		X
SEHE8	<i>Sesbania herbacea</i>	coffeeweed	X	
SETARIA	<i>Setaria sp.</i>	foxtail species	X	X
SIAN	<i>Sicyos angulatus</i>	bur cucumber	X	
SYSP	<i>Symphyotrichum sp.</i>	<i>Symphyotrichum</i> species		X
XAST	<i>Xanthium strumarium</i>	cocklebur	X	X
UNSP	Unknown sp.	Unknown species	X	X

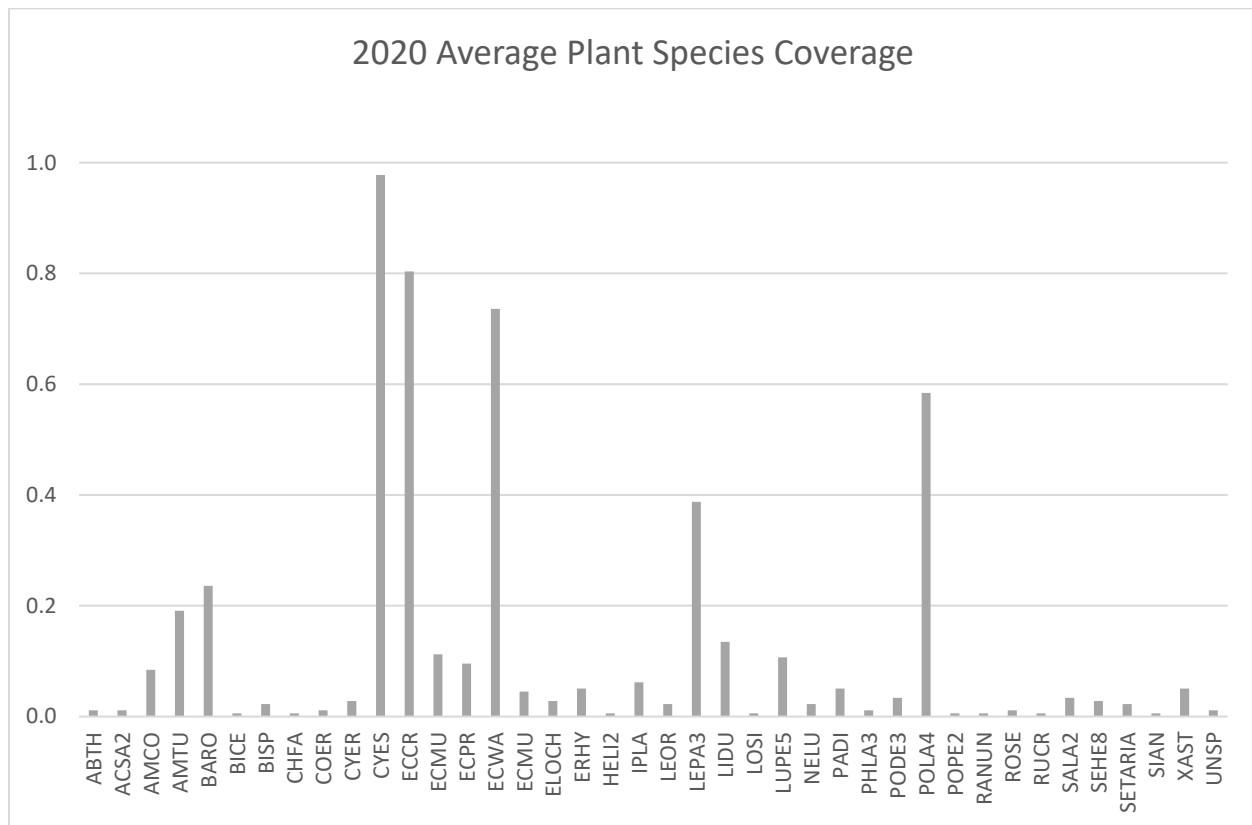


Figure 5. Average percent cover class by species at vegetated plots, 2020.

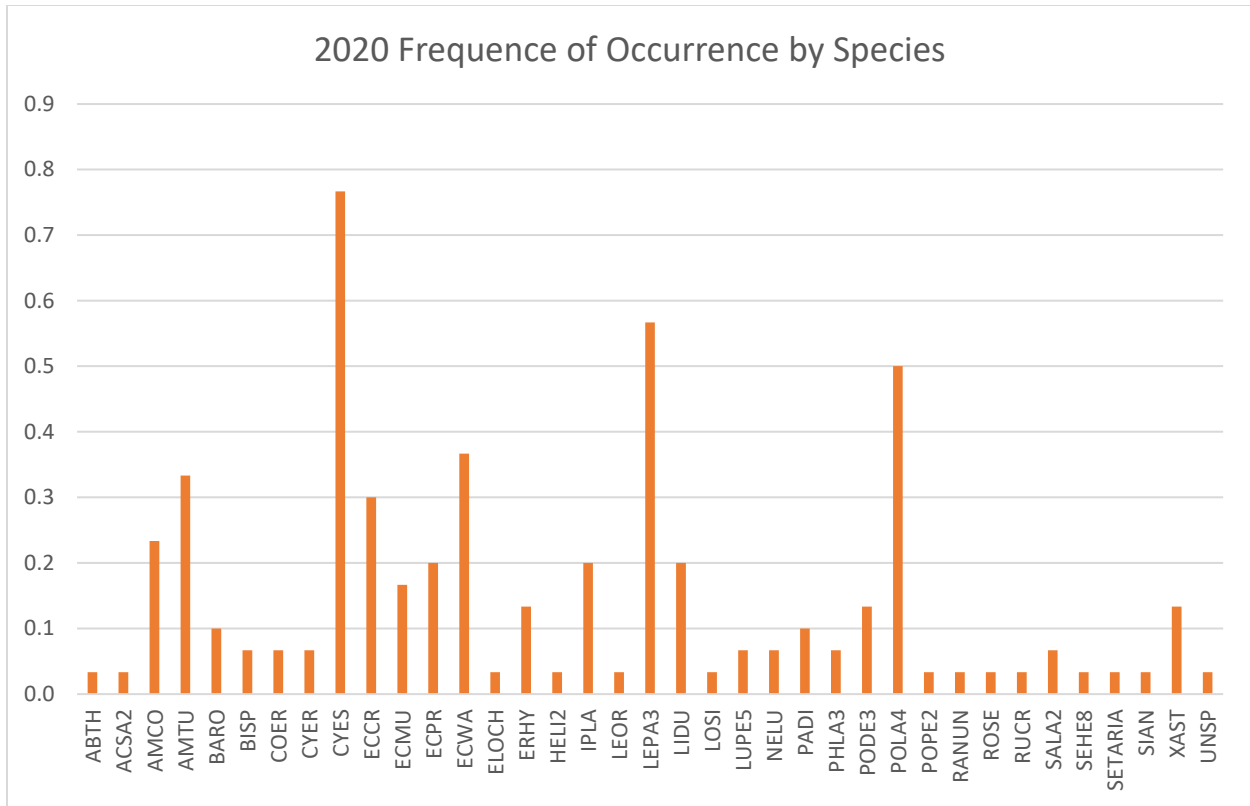


Figure 6. Frequency of occurrence by species at LTRM vegetation survey locations, 2020.

4.3 Transect vegetation surveys

4.3.1 Methods

Following the Illinois Natural History Survey, Critical Trends Assessment Protocol (CTAP) for Wetland sites (INHS 2002), a transect is placed perpendicular to the long axis of the wetland. A random distance along the transect is then selected to establish a baseline. When laying the transect, the tape measure is pulled taut and laid on the ground at all points along its length. Herbaceous vegetation is sampled in $\frac{1}{4}$ m² quadrats at an interval of every 2 m along the transect, starting 2 m from the baseline (Figure 7). A total of 20 quadrats are sampled per site. Quadrats are placed 1 m from the transect on alternate sides, starting on the left at the 2 m 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). At each quadrat, all species present were identified and assigned a percent cover rating between 1 and 7. Cover ratings related to species percent cover are as follows: 1) <1%, 2) 1-5%, 3) 6-25%, 4) 26-50%, 5) 51-75%, 6) 76-95%, and 7) 96-100%. Average species percent cover, frequency of occurrence, species richness, Shannon's diversity index, and Shannon's equitability index were computed based on field data.

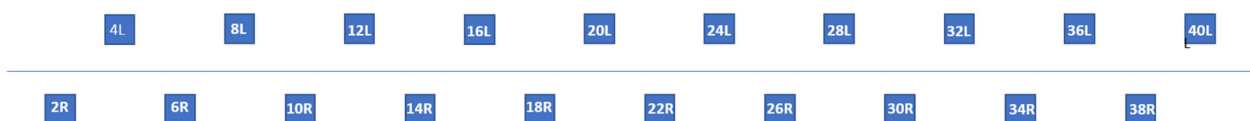


Figure 7. Quadrat layout along transect.

4.3.2 Results

Twenty-five species were recorded during transect sampling (Table 6). In Pool 26, average percent cover class values were greatest for yellow nutsedge and wild millets (*Echinochloa* spp.). Nodding smartweed had a locally higher percent cover class value at Ellis Bay. Amazon sprangletop had greater percent cover class values at Eagle’s Nest Island and Alton Lake area, and scarlet toothcup (*Ammania coccinea*) had greater percent cover class values at Eagle’s Nest Island and Mile 210 area (Figure 8). Frequency of occurrence by species followed similar patterns to overall cover (Figure 9). Many of the dominant species in 2020 are indicative of a mid-season drawdown that supported a diversity of species and development of multiple layers of vegetation (Figures 8 and 9).

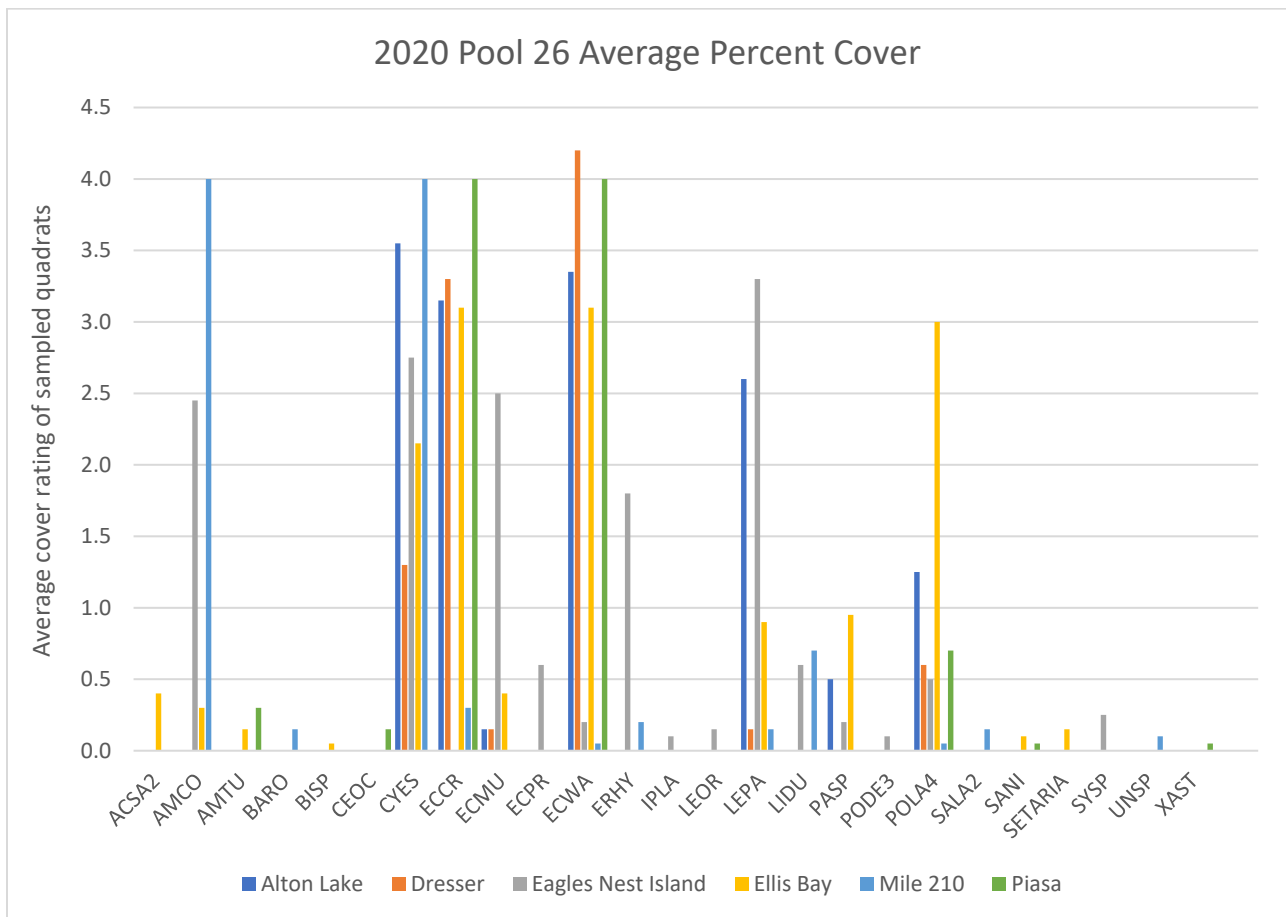


Figure 8. Average plant species percent cover rating, Pool 26 sampling sites, 2020. Percent cover ratings were recorded per quadrat as follows: 1) <1%, 2) 1-5%, 3) 6-25%, 4) 26-50%, 5) 51-75%, 6) 76-95%, and 7) 96-100% and then averaged to compute a percent cover rating per site.

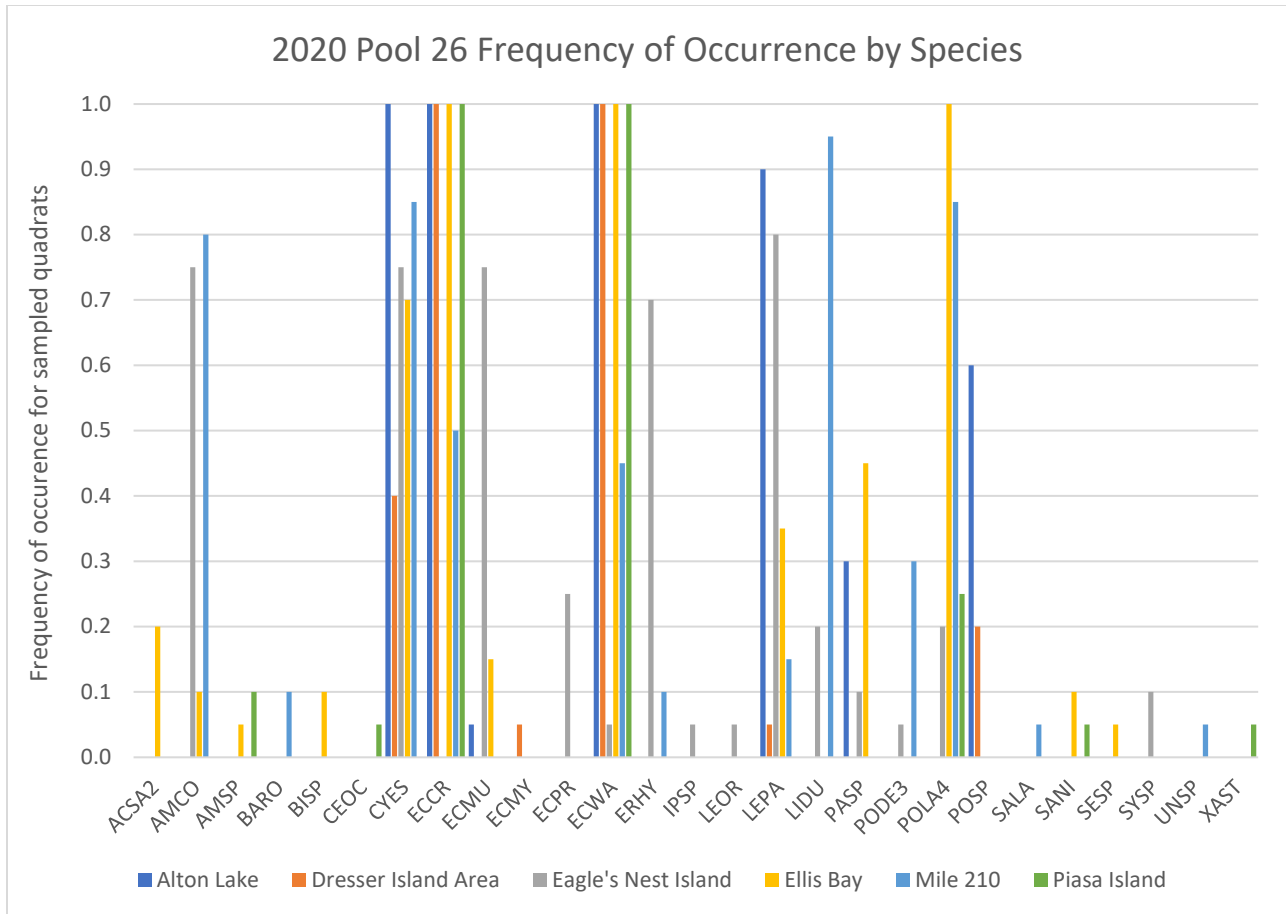


Figure 9. Plant species frequency of occurrence, Pool 26 sampling sites, 2020.

Diversity Values Overall

Ellis Bay, Alton Lake and Piasa Island had the highest species richness values per site and Mile 210 area and Dresser area had the lowest species richness values per site in 2020 (Figure 10). Most sites supported relatively diverse emergent plant communities (Figure 11).

4.4 Comparison to Reese and Lubinski (1983) survey of floodplain vegetation

Three plant community types are described in Reese and Lubinski (1983) that overlap with flora typical of areas that could be exposed by EPM actions and include river, riverbank, and backwater community types. The following sections describe the pre-1993 period as well as current plant communities.

River Aquatic Community

This community included vascular plants that grow in the river during normal water levels. The community occurs in areas where substrate slope is gradual and river current permits deposition of fine-grained sediment. The authors noted that vegetation composition across years can vary significantly, and that recovery of aquatic beds may take several years if aquatic species are displaced or stressed during vulnerable life stages.

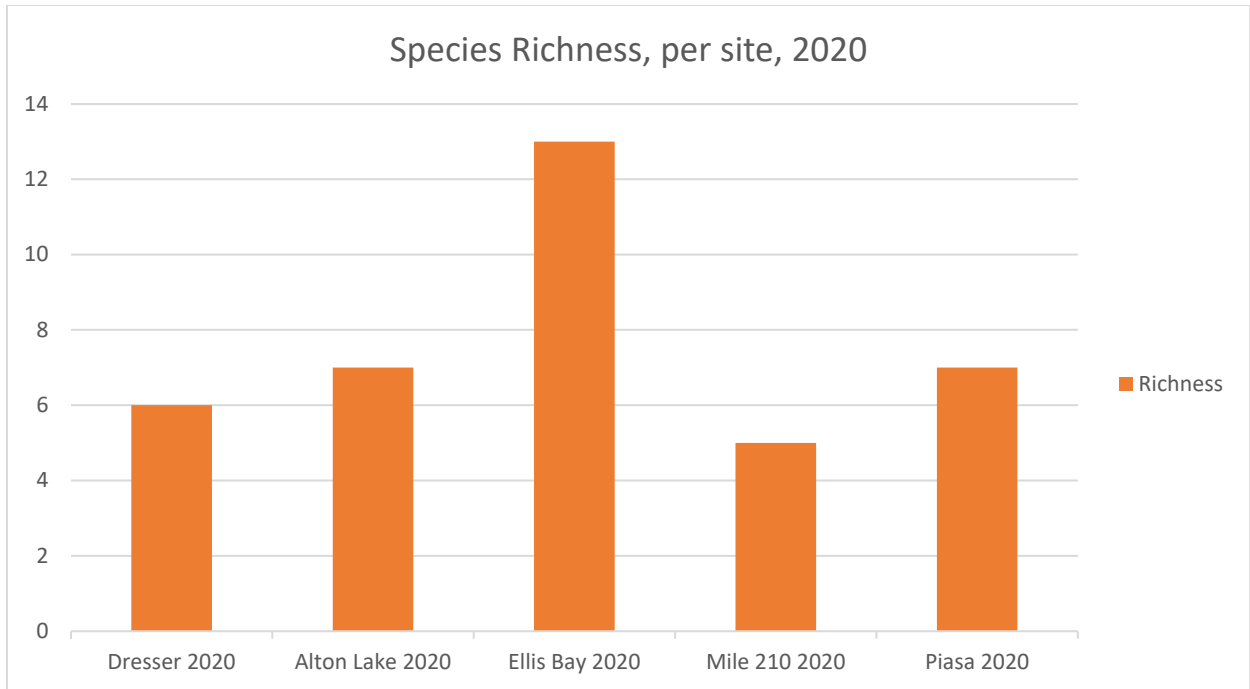


Figure 10. Species richness, Pool 26 sampling sites, 2020.

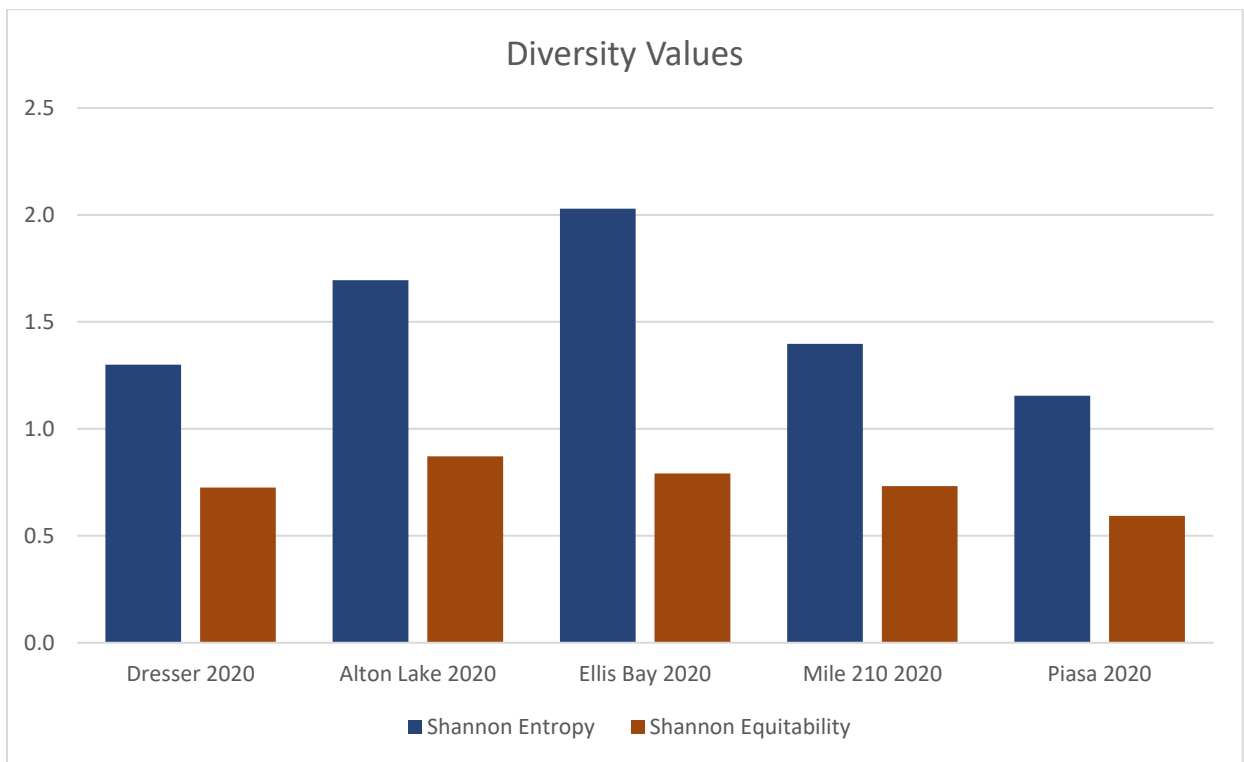


Figure 11. Shannon's diversity and equitability, Pool 26 sampling sites, 2020.

Reese and Lubinski (1983) noted five species of submergent aquatic plants, including *Potamogeton pectinatus*, *Potamogeton nodosus*, *Potamogeton crispus*, *Najas guadalupensis*, and *Zosterella dubia*, and 7 dominant species of emergent, including arrowhead (*Sagittaria latifolia*), American lotus (*Nelumbo lutea*), *Typha latifolia*, *Jussiaea repens*, *Scirpus fluviatilis*, *Scirpus Validus*, and *Sparganium* spp. in the river aquatic community. Only arrowhead and American lotus were noted in 2020 in some of their historic locations. Arrowhead was found in the Mile 210 and Mile 215 area and lotus was found in the Alton Lake area (not visited by Reese and Lubinski but noted by area managers prior to the historic 1993 flood in this area). The remaining species were not observed during our plant sampling efforts. Additionally submerged plant species have not been recorded since the 1990's. Attempts to establish submersed aquatic plantings on the lower pools of the Mississippi and Illinois Rivers have not been successful after the 90s due to several interacting factors that are less optimal for establishment. The factors include: herbivory, low water clarity, and rapid fluctuations pool elevations (Sass et al., 2017) (Carhart et al., 2021). Emergent species such as *Jussiaea repens* and *Sparganium* spp. were not recorded at surveyed sites in recent years.

Riverbank Community

This plant community captures the zone along the edges of the river that are exposed during portions of the growing season as a result of typical annual water fluctuations. Essentially, it captures emergent vegetation and some woody species that regenerate in this zone. Reese and Lubinski (1983) noted *Leersia oryzoides*, *Eragrostis* spp., *Echinochloa* spp., *Cyperus* spp., *Eleocharis*, *Ammania coccinea*, *Lindernia dubia*, *Rorippa islandica*, *Amaranthus tuberculatus*, *Asclepias incarnata*, *Commelina diffusa*, *Polygonum* spp., *Bidens*, *Mimulus* spp., and *Symphyotrichum* (formerly Aster), *Leptochloa*, *Juncus* and others. This list of characteristic species matches up well with species composition typical of island edge in 2020 and other recent years that we have evaluated EPM vegetation. Only *Asclepias incarnata* and *Mimulus* spp. were not recorded during our assessment.

Backwater Community

The backwater community included areas inundated by water at normal water levels and wetland areas surrounding them (Reese and Lubinski, 1983). The periphery shared plant species typical of riverbank and river aquatic communities. At the time, extensive submersed aquatic vegetation beds occurred, comprised of *Ceratophyllum demersum*, *Potamogeton pectinatus*, *Elodea nuttallii*, *Najas guadalupensis*, *Potamogeton nodosus*, *Potamogeton pusillus*, and *Potamogeton crispus*. These species have not reestablished within existing backwater areas. However, the emergent species that were characteristic then still are the most abundant species encountered during EPM assessments and include *Eragrostis*, *Cyperus*, *Echinochloa*, *Polygonum*, and *Leersia*.

5. Conclusion

Overall, many of the species typically representative of emergent wetland during the 1983 survey were encountered at multiple locations during EPM surveys in 2020. The longer duration environmental pool management period in 2016, 2017, and 2018 did appear to encourage arrowhead colony growth and germination of lotus at a couple locations, but a long duration flood in 2019 appeared to set back arrowhead colonies in 2019 and 2020. The longer duration drawdown for three consecutive years was

not enough to support the submersed aquatic species identified by Reese and Lubinski (1983). Disturbance from carps, herbivory, and turbidity is thought to limit initial recruitment of these aquatic species and may require more consecutive years of drawdowns to establish. In addition, water fluctuation has also been noted to impact submersed aquatic species, with more stable water areas more conducive to submersed aquatic establishment. Intense storms systems that contribute large volumes of runoff throughout the UMRS, and which can force rapid fluctuations in pool water elevations could also limit establishment of submersed aquatic vegetation in backwater areas that are connected to the channel.

6. References

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