Sustainable Rivers Program

Mississippi River (Pool 26)
Modifying Water Levels to Enhance Migratory Shorebird Habitat - 2023

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September 2024

Above: Ellis Bay mudflat with larval chironomids, Lower Pool 26, Mississippi River (USACE photo).

Contents

1 Introduction

The Upper Mississippi River System is located at the center of one of the primary migratory pathways in North America and is historically significant for migratory shorebirds. Shorebirds depend on shallowly flooded and recently flooded mudflats and sandbars to access invertebrate prey. This is a habitat type that can be limiting on the current landscape in our region due to land use change and the altered hydrology on the Illinois and Mississippi Rivers. Mudflats and sandbars are limited partially as a result of the system of locks and dams that are operated to support navigation and other purposes for those rivers. The area above Mel Price Locks and Dam (Pool 26) has recorded at least 39 species of shorebirds since the early 1990s with high concentrations of migratory shorebirds when suitable habitat is available. This report will summarize SRP funded implementation and monitoring related shorebird work for 2023. In 2023, sampling of sediment moisture and substrate suitability for shorebird foraging occurred in April when water levels exposed mudflats just upstream of Mel Price Locks and Dam. Ecological responses were monitored by gathering and assessing the following data:

- *Shorebird utilization of exposed sediments*
- *Sediment and invertebrate data from mudflat habitat*
- *Videos and photos of habitat use by shorebirds*

1.1 Lower Pool 26 Conditions

Mel Price Locks and Dam is operated using the hinge point method, which involves drawing down the pool as river flows increase such that river stage at the hinge point, typically mid-pool, remains relatively constant. In early April 2023, the pool was drawn down for an extended period, which subsequently exposed large mudflats in lower Pool 26 just upstream of Mel Price Locks and Dam. Experimenting with modified water levels for short duration could not be conducted during spring of 2023 due to management considerations for lake sturgeon from April through mid-May and environmental conditions through the end of May.

Figure 1 shows Mel Price pool stages during spring of 2023. The main drawdown lasted about two months (April-May) and was characterized by near constant daily stages with only small fluctuations. At the end of May, flows and river levels increased, inundating mudflats at the tail end of the spring migratory shorebird period.

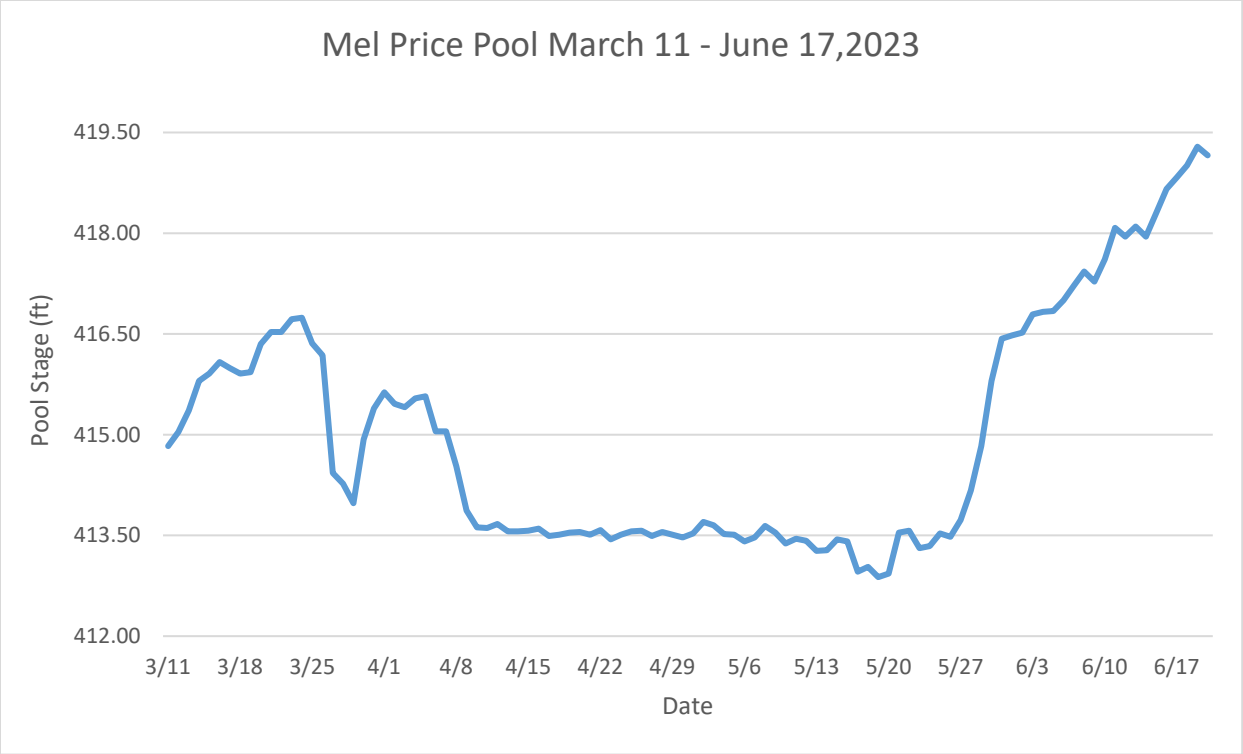

Figure 1. Spring pool stages (in feet), Mel Price Locks and Dam.

2 Methods

Potential habitat available for shorebird foraging is high in Lower Pool 26 due to the prevalence of relatively flat areas with substrate that are exposed as pool levels are reduced (Figures 2-4). Conditions within the study area were evaluated utilizing several methodologies to assess direct use of habitats and to assess habitat conditions when birds are absent. This evaluation was done because "good" habitat conditions do not always correlate with high bird-use of habitats due to the migratory nature of shorebird species and the generally patchy distribution of habitat on the landscape.

Shorebird use was monitored via visual observations in April 2023. Sediment, soil moisture, and macroinvertebrate samples were collected at three sites, one transect per site, three samples per transect for a total of nine samples, on six separate dates. Samples were gathered on April 4, 6, 11, 12, 26, and 27. The six dates overlapped with the lake sturgeon spawning period so no water manipulations were attempted. Instead, this data was gathered to provide a baseline from which we could assess future water manipulation attempts to enhance shorebird habitat.

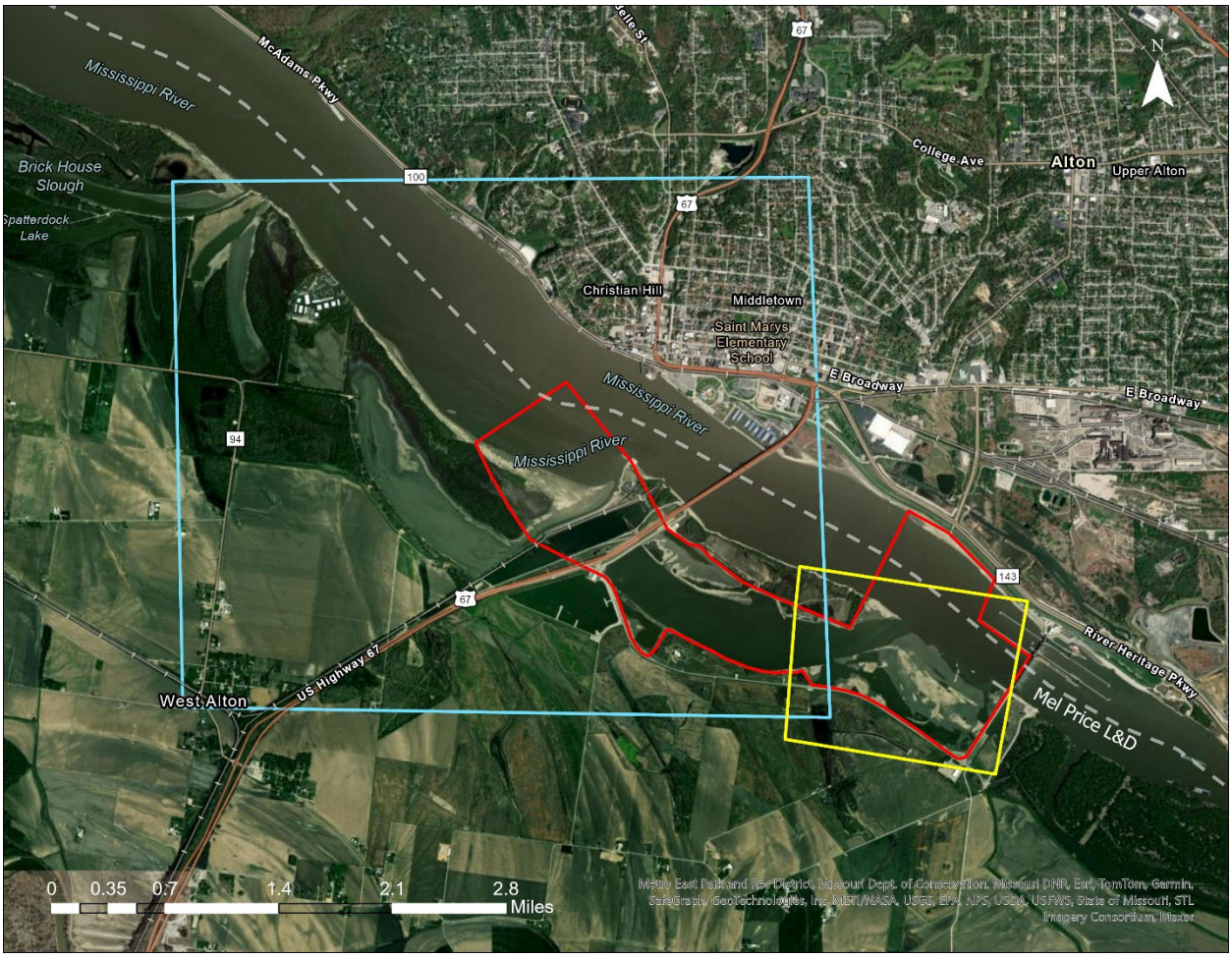

Figure 2. Overview map of sampling areas and Riverlands Migratory Bird Sanctuary units that could be influenced by the water management in the river for shorebirds. Polygon insets correspond to the spatial extents of figures 3 (yellow), 4 (blue), and 5 (red).

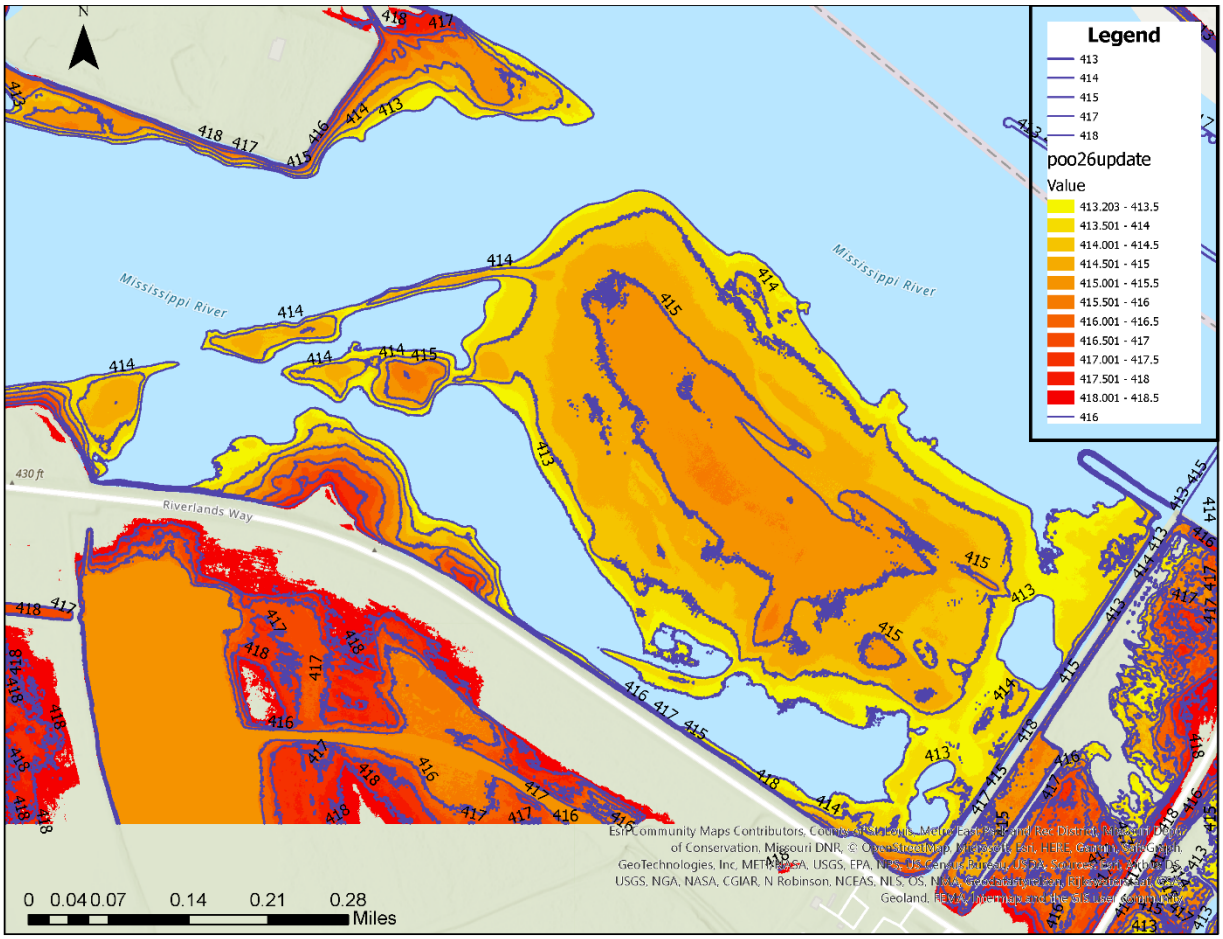

Figure 3. 2018 LiDAR of Lower Pool 26 showing potential mudflat habitat elevations with 1 ft contours. Area shown includes units C and F from the Riverlands Migratory Bird Sanctuary (figure 5), which are located immediately above Mel Price Locks and Dam.

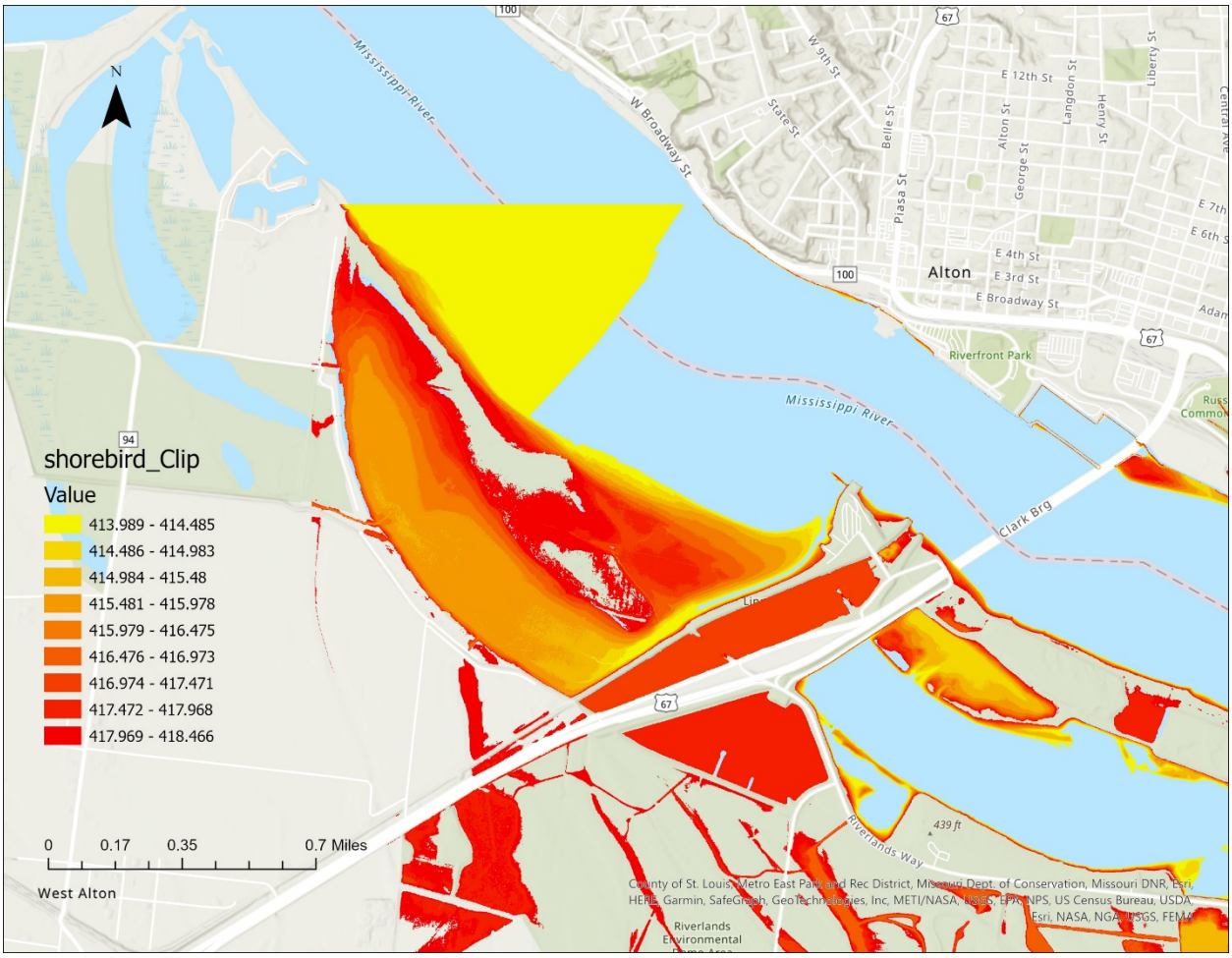

Figure 4. 2018 LiDAR of Unit P and Q showing additional areas with high potential for shorebird habitat management. Areas in orange and red show areas of greatest potential for shorebird use. Area shown includes units P and Q from the Riverlands Migratory Bird Sanctuary (figure 5).

2.1 Shorebird Use

Shorebird usage data was derived from local, expert birders in the region that frequently document usage of the various habitats within Riverlands Migratory Bird Sanctuary. This provides summary usage information throughout the entire migratory period (March to early June).

Additional data was provided by Rivers Project Office staff that conducted Integrated Waterbird Management and Monitoring (IWMM) protocol surveys (USFWS, 2021) to assess shorebird use weekly from late April through late May. The Ellis Bay and Lincoln Shields Areas, located in the Riverlands Migratory Bird Sanctuary just upriver from Mel Price Locks and Dam, were divided into multiple units to ensure that all areas within a unit can be visually seen and surveyed from a single point (Figure 5). A trained observer identified all waterbird species utilizing the unit and recorded the total number by species. Conditions were visually estimated for each of the units and the proportion of area in each water depth category was recorded (% dry, % saturated mud, % water depth 2.0-9.8 in (5-25 cm), % > 9.8 in (25 cm) water depth).

Figure 5. Riverlands Migratory Bird Sanctuary IWMM Units along the Mississippi River.

2.2 Sediment Sampling

Sediment samples were taken along transects oriented perpendicular to the shoreline, starting at the water surface/shoreline intersection (Figure 6). Soil moisture and invertebrate samples were taken at 1.6 ft (0.5 m), 8.2 ft (2.5 m), and 14.8 ft (4.5 m) from the shoreline and away from the water (Figure 7). Soil moisture samples were gathered from the top 1.5 in (3.8 cm) with a square tablespoon that gathered a sediment sample of approximately 0.90 in^3 (14.78 cm^3). Each sediment sample was transferred to a labeled bag and processed at the end of the day. Macroinvertebrate samples were gathered utilizing a 4.0 in (10.2 cm) diameter PVC Schedule 30 pipe to a depth of 2.0 in (5.0 cm). Sediment was scooped from the PVC tube sample area and transferred to separate labeled gallon bags and placed in a cooler to prevent desiccation or damage to macroinvertebrates until samples could be processed later the same day. The volume of each sample was approximately 19.8 in^3 (324 cm^3). Equipment was cleaned and dried between sample collections.

Figure 6. Sediment sampling locations. Each location was revisited over multiple days to evaluate changes in sediment moisture and macroinvertebrates along transects.

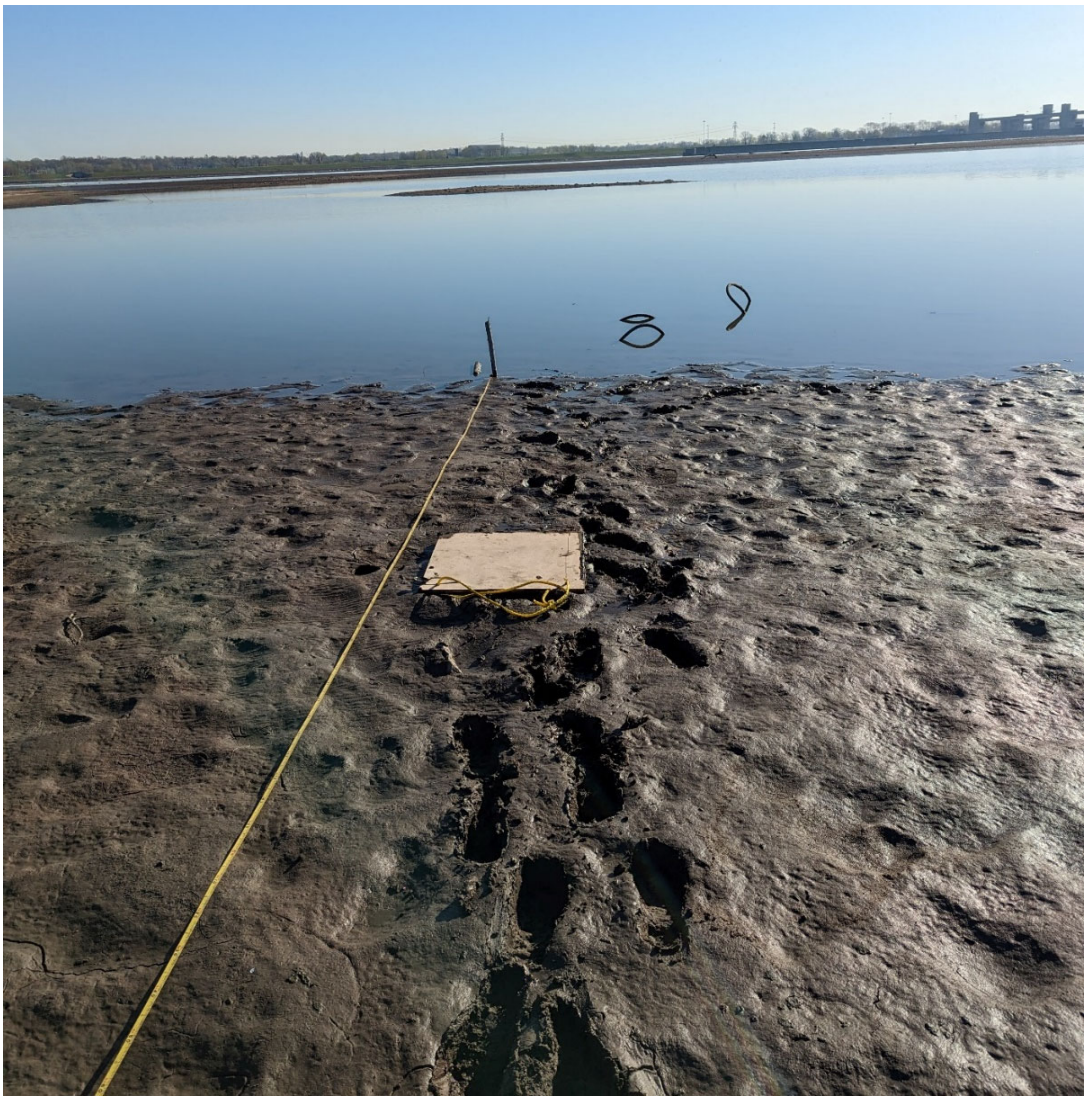

Figure 7. Transect oriented perpendicular to water edge used to gather sediment samples from over multiple days (USACE photo).

2.2.1 Soil Moisture Processing

Small aluminum tins 2.9 inches (7.4 cm) in diameter were labeled for each soil moisture sample. Sample tins were weighed utilizing an electronic scale (± 0.00035 ounces; ± 0.001 grams) and recorded. Samples were then transferred to the corresponding tin and weighed to record wet weight (+ tin weight). Next samples were transferred to a low temperature (100°F/38°C) heating mat and dried over approximately 48 hours until the weight of samples were stable (i.e., no additional water loss from samples). Samples were then transferred to a sealed container with a layer of silica desiccation beads under sample tins until samples returned to room temperature to prevent resorption of water. Samples were then weighed to provide dry weights (+ tin weight). Percent moisture by weight was calculated utilizing the following formula:

Percent moisture = ((wet weight - tin weight) - (dry weight - tin weight)) / (wet weight - tin weight) * 100

2.2.2 Macroinvertebrate Sample Processing

Macroinvertebrate samples were processed the same day that samples were collected utilizing a fog nozzle (0.6 gallons per minute; 1.9 liters per minute) to gently rinse sediment through a series of soil sieves (#5, #10, #40, #60) with corresponding mesh diameters of 0.1575 in, 0.0787 in, 0.0157 in, 0.0098 in (4 mm, 2 mm, 0.4 mm, 0.25 mm) to separate invertebrates from substrate components. Macroinvertebrates were identified with the aid of a 10X loupe when needed, tallied by type utilizing counters, and transferred to glass collection vials containing 90% isopropyl alcohol to preserve samples for later identification. Unknown samples were keyed out under a dissecting scope (10-30X) to at least family level.

2.3 Trail Cameras and Video

Two Bushnell™ cameras (Trophy Cam E3) were programmed at a maximum resolution (16 megapixel) to take pictures when activated by motion of bird use and water fluctuations during the spring shorebird migration period. Placement of cameras occurred on 6 April 2023. One camera was located at the southern edge of IWMM Unit P and one camera was placed on the west slope of the spillway adjacent to Mel Price Locks and Dam. The camera at IWMM Unit P was secured to a tree approximately 10 feet above the maximum regulated pool level. Small branches were removed from the camera's field of view to help capture more of the mudflat area. The camera placed on the slope of the spillway was attached and cable-locked to a 10ft T-post that was hammered approximately 3 feet into the sediment.

The camera at IWMM Unit P was recovered on 1 June 2023 as the shorebird migration was ending and Pool 26 water levels were increasing. By 1 June 2023, the camera near the spillway was inaccessible but was able to be recovered on 20 June 2024. Due to equipment malfunction from environmental conditions the SD card and camera were inoperable and images could not be recovered from the spillway area camera. The camera at IWMM Unit P was not activated by shorebirds or wading birds during that camera's deployment period. The camera was only triggered by fishermen on one occasion as they accessed a nearby fishing spot. As a result, only personal photos were captured during the sampling periods as a result of the trail camera issues this field season.

3 Monitoring Results

A summary of bird observations from expert birders in the region is provided below in Table 1. IWMM data was gathered weekly and summarized for the months of late April through late May to provide a summary of bird use (Table 2). Sediment samples were gathered to evaluate conditions and substrate suitability (Figure 8, Table 3, and Table 4).

Table 1. Shorebird observations at Riverlands Migratory Bird Sanctuary March-May 2023.

Species	# observed
American Avocet	1
American Golden-Plover	185
Baird's Sandpiper	15
Black-bellied Plover	12
Dunlin	50
Forster's Tern	4
Greater Yellowlegs	150

Species	# observed
Hudsonian Godwit	1
Least Sandpiper	313
Lesser Yellowlegs	300
Lesser/Greater Yellowlegs	92
Long-billed Dowitcher	29
Pectoral Sandpiper	400
Red-necked Phalarope	1
Sanderling	5
Semipalmated Plover	48
Semipalmated Sandpiper	250
Short-billed Dowitcher	23
Short-billed/Long-billed Dowitcher	16
Snowy Plover	1
Solitary Sandpiper	10
Spotted Sandpiper	10
Stilt Sandpiper	10
Wilson's Phalarope	8
Wilson's Snipe	10
Total	*1944*

Table 2. IWMM shorebird data (individuals observed), April-May at Riverlands Migratory Bird Sanctuary.

Riverlands Weekly Waterbird Survey	4/26/23	5/3/23	5/11/23	5/16/23	5/22/23
Wilson's Snipe	4	0	0	0	0
Greater Yellowlegs	0	0	0	0	0
Lesser Yellowlegs	8	13	5	1	0
Black-necked Stilt	0	0	1	0	2
Dunlin	0	0	0	0	1
Least Sandpiper	0	2	189	21	3
Spotted Sandpiper	1	8	0	0	1
Semipalmated Sandpiper	0	0	5	30	21
Pectoral Sandpiper	0	0	9	19	0
White-rumped Sandpiper	0	0	0	0	2
Long-billed Dowitcher	0	0	1	0	0
Semipalmated Plover	0	0	5	31	0
Black-bellied Plover	0	0	0	0	1
Killdeer	2	6	11	10	9
Sandpiper spp.	19	19	0	0	0
Short-billed/Long-billed Dowitcher	0	0	10	0	0
Total Shorebirds	*34*	*48*	*236*	*112*	*40*

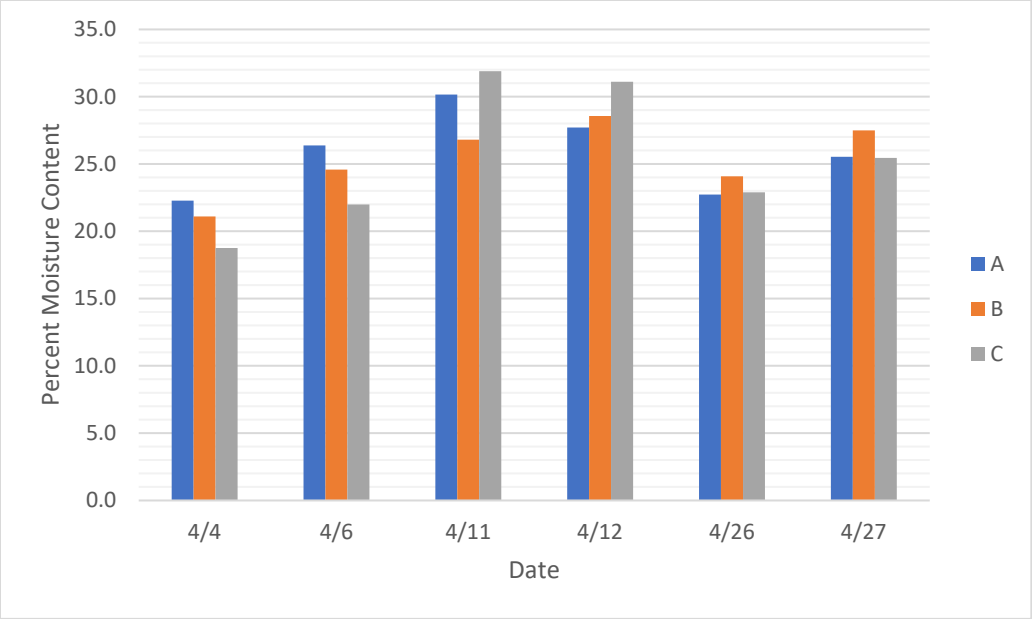

Figure 8. Percent moisture content by distance along transects away from water. A = 1.6 ft (0.5 m), B = 8.2 ft (2.5 m), C= 14.8 ft (4.5 m).

Table 3. Invertebrate count by distance and sample along transects.

Date	Sample	Distance (ft)	Aquatic worms	Beetle	Midge (Chironomids)	Sample Total
4/4/2023	1a	1.6	-	-	1	1
4/4/2023	1b	8.2	-	-	-	0
4/4/2023	1c	14.8	-	-	-	0
4/4/2023	2a	1.6	-	-	1	1
4/4/2023	2b	8.2	1	-	-	1
4/4/2023	2c	14.8	-	-	-	0
4/4/2023	3a	1.6	5	-	2	7
4/4/2023	3b	8.2	2	-	5	7
4/4/2023	3c	14.8	2	-	3	5
4/6/2023	4a	1.6	6	-	2	8
4/6/2023	4b	8.2	12	-	13	25
4/6/2023	4c	14.8	9	-	2	11
4/6/2023	5a	1.6	11	-	3	14
4/6/2023	5b	8.2	2	-	2	4
4/6/2023	5c	14.8	2		4	6
4/6/2023	6a	1.6	3	-	1	4
4/6/2023	6b	8.2	1	-	1	2
4/6/2023	6c	14.8	1	-	3	4
4/11/2023	7a	1.6	16	-	8	24
4/11/2023	7b	8.2	29	-	15	44
4/11/2023	7c	14.8	10	-	9	19

Date	Sample	Distance (ft)	Aquatic worms	Beetle	Midge (Chironomids)	Sample Total
4/11/2023	8a	1.6	1	-	20	21
4/11/2023	8b	8.2	13	-	8	21
4/11/2023	8c	14.8	8	-	-	8
4/11/2023	9a	1.6	4	-	5	9
4/11/2023	9b	8.2	12	-	1	13
4/11/2023	9c	14.8	6	-	5	11
4/12/2023	10a	1.6	14	-	10	24
4/12/2023	10b	8.2	7	-	4	11
4/12/2023	10c	14.8	9	-	10	19
4/12/2023	11a	1.6	25	-	7	32
4/12/2023	11b	8.2	12	-	6	18
4/12/2023	11c	14.8	6	-	2	8
4/12/2023	12a	1.6	6	-	4	10
4/12/2023	12b	8.2	6	-	1	7
4/12/2023	12c	14.8	7	-	4	11
4/26/2023	13a	1.6	43	-	2	45
4/26/2023	13b	8.2	10	1	-	11
4/26/2023	13c	14.8	6	-	1	7
4/26/2023	14a	1.6	25	-	2	27
4/26/2023	14b	8.2	-	-	4	4
4/26/2023	14c	14.8	4	-	1	5
4/26/2023	15a	0.5	19	-	1	20
4/26/2023	15b	2.5	1	-	12	13
4/26/2023	15c	4.5	-	-	-	-
4/27/2023	16a	1.6	13	-	1	14
4/27/2023	16b	8.2	6	-	1	7
4/27/2023	16c	14.8	1	-	-	1
4/27/2023	17a	1.6	38	-	3	41
4/27/2023	17b	8.2	11	-	4	15
4/27/2023	17c	14.8	1	-	5	6
4/27/2023	18a	1.6	12	-	1	13
4/27/2023	18b	8.2	6	-	1	7
4/27/2023	18c	14.8	2	-	2	4
Overall total by Species			446	1	203	650

Table 4. Average density per 1 m^2 (10.7 ft^2) sample by distance along transects.

Transect Distance (ft)	Aquatic worms	Midge
1.6	823.4	252.8
8.2	447.6	266.5
14.8	267.7	184.5

4 Discussion

Coordination with the Water Control Section, St. Louis District, U.S. Army Corps of Engineers, occurred through spring 2023 to identify periods when short duration water level fluctuations could be implemented for the project while maintaining conditions within operational limits identified in the Mel Price L&D Water Control Plan. In 2023, a longer duration of high inflows at Mel Price prior to the lake sturgeon spawning season prevented attempting early shorebird season habitat management trials; attempts to implement water management trials were paused during the lake sturgeon spawn period. Unfortunately, flows did not decrease until the end of the shorebird migratory season, and when they did it was an abrupt drop that required the pool levels to be raised above the mudflat elevation. This resulted in the complete inundation of mudflats at the end of the migratory shorebird season. Communication about anticipated conditions allowed us to gather some baseline data on mudflats in our study area during April to assess overall suitability of shorebird habitat without management. While the data cannot be used to inform frequency of inundation, it does help to demonstrate that invertebrates occur at suitable densities to support migratory shorebirds (> 100 midge larvae per 10.7 ft^2) (Eldridge, 1992).

4.1 Shorebird Use

Bird observations recorded by birders in the region between March and May (Table 1) were comprised of nearly 2,000 shorebirds representing 24 species. Pectoral sandpiper, lesser yellowlegs, least sandpiper, semipalmated sandpiper, American golden plover, and greater yellowlegs were the most frequently observed, accounting for over 80% of observations. Pectoral sandpiper, least sandpiper, American golden plover, and greater yellowlegs typically arrive in small number by March. Lesser yellowlegs and semipalmated sandpiper typically arrive in April. All six species frequently utilize mudflats in the Riverlands Migratory Bird Sanctuary and tend to peak in number in April or May.

Based on data gathered by biologists at Rivers Project Office, the least sandpiper, semipalmated sandpiper, killdeer, semipalmated plover, and pectoral sandpiper occurred in the largest number during late April through much of May (Table 2). Surveys were planned earlier in the season but could not be completed due to changes in staffing.

4.2 Sediment Moisture

Sediment moisture samples were gathered along the perimeter of mudflats to evaluate sediment moisture conditions near the transition zone from water to land where shorebirds spend most of their time foraging. Samples were gathered at 1.6 ft (0.5 m), 8.2 ft (2.5 m), and 14.8 ft (4.5 m) for all sampling dates. Overall, moisture values were quite variable within and across distance intervals and as a result there were no significant differences in percent sediment moisture among intervals. Slight fluctuations in elevation and sediment composition may account for this variability since the mudflat slope isn't completely smooth. Additionally, sediment moisture is calculated overall for a sample which may not capture important differences in moisture that occur at the surface and may affect probing efficiency by shorebirds.

4.3 Trail Cameras and Video

Trail cameras that were deployed for the 2023 season were unsuccessful at capturing the types of images we were aiming to collect. As a result, we were only able to collect photos during sampling events (Figures 8 to 11).

Figure 8. Several shorebirds utilizing recently exposed mudflats in Ellis Bay, located immediately upstream of Mel Price Locks and Dam in the Riverlands Migratory Bird Sanctuary, 26 April 2023. Relatively stable water levels over an extended period of time in combination with a low elevation gradient and finer grained sediment results in a gradual change in moisture levels at the surface of mudflats near the water edge (USACE photo).

Figure 9. Shorebirds and waterfowl utilizing recently exposed mudflats in Ellis Bay located immediately upstream of Mel Price Locks and Dam in the Riverlands Migratory Bird Sanctuary. The influence of the 0.8-foot drop in pool elevation overnight in combination with sediment composition and the lack of precipitation results in a visible line separating saturated soils from soils that are drying out at the surface, 27 April 2023 (USACE photo).

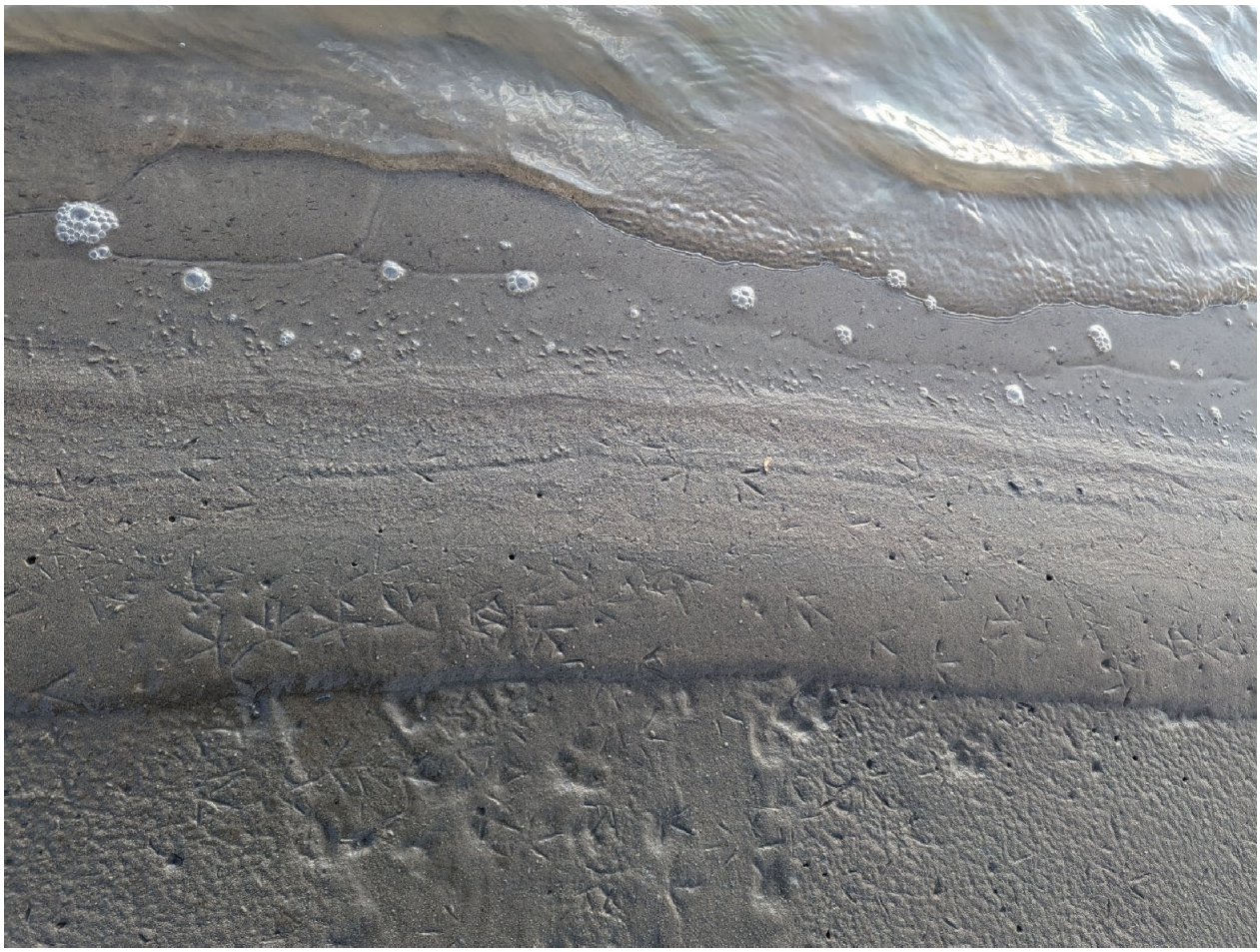

Figure 10. Tracks from shorebirds and waterfowl recently foraging along the edge of the mudflats, 26 April 2023 (USACE photo).

Figure 11. Pelicans group along the edge of distant mudflats exposed in Ellis Bay, 4 April 2023 (USACE photo).

4.3 Macroinvertebrates

Macroinvertebrates captured per sample varied widely and included a variety of aquatic worms, midge larvae, and aquatic beetles. Midge larvae make up a significant dietary component of many species of waterbird while aquatic worms (oligochaetes) tend to be eaten at lower levels despite their availability (Smith et al., 2012). The target midge density for managed shorebird habitat is 100 or more midge larvae per meter squared surface area of mudflat (Eldridge, 1992). Based on our sampling size, 0.785 midges per sample would be needed to meet this threshold. Overall, midge larvae varied from 0-20 per sample. One hundred percent of samples at 0.5 m, 83% at 2.5 m, and 72% at 4.5 meters met the minimum number of midges needed to provide suitable shorebird habitat. Additional sampling will be needed to evaluate suitability of habitat at different distances from the water line across a range of management conditions.

5 Conclusion

The inflows being managed at Mel Price L&D this year made it challenging to implement a pulse trial to rewet the edges of mudflat in Ellis Bay. Potential conditions improved to be able to attempt a trial but then the lake sturgeon spawning season began. Flows were managed to improve lake sturgeon spawning habitat conditions, and as a result we were not able to implement any trials for shorebirds in 2023 (two trials were done in 2022, USACE 2024). The team gathered samples opportunistically relative to small changes in water elevations that occurred as a result of changing inflows at Mel Price L&D. This gave us a chance to sample under conditions with different durations of sediment drying and exposure. The sampling found that on average, Ellis Bay supports macroinvertebrates (midge larvae) at suitable levels to support shorebirds. However, not all areas with suitable prey densities may be accessible for foraging due to surface conditions that change in relation to the drying effects of wind, sun exposure, and drops in river water elevations. In an attempt to increase our ability to manage conditions for shorebirds we are proposing to move the study to the Kaskaskia River in 2024 where there will be fewer management constraints in the spring. The lower Kaskaskia River has a series of oxbow wetlands as well as emergent wetlands that are connected and influenced by water elevations in the river channel and are managed by Operations staff.

6 References

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