GREENFIELD/ELIZA LOWER BROWNS

POST-CONSTRUCTION FISH MONITORING

2012 Survey Results

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INTRODUCTION

The American Recovery and Reinvestment Act (ARRA; 2010) provided funds for construction and monitoring of innovative structures, which were designed to reduce dredging in the area and create a more self-sustaining navigation channel. The W-dike and multiple round point structures (MRS) structures are designed to permanently alter the pattern of scour and deposition around them. Additionally, the structures may affect scour and deposition differently than traditional dikes, thus potentially creating diverse habitat for various aquatic species. To date, very little fish assemblage monitoring at W-dikes, notched dikes, and MRS structures has been done little in the open river. This survey provides information on the fish assemblage using these innovative structures compared to traditional structures. This information will assist decision making and inform design of future river training structures elsewhere in the MMR.

The U.S. Army Corps of Engineers (USACE), St. Louis District (District) conducted post-construction biotic (fish) and abiotic (sediment, water quality, bathymetry, and velocity) sampling to compare fish assemblages and physical habitat between an experimental site and a control site. The experimental site is comprised of innovative structures (a W-dike, multiple round point structures (MRS), and a notched dike) located near Middle Mississippi River (MMR) river mile (RM) 3.8L-4.4L; the control site consists of a series of three traditional un-notched dikes located near RM 18.0R-19.0R (Figure 1).

This report provides a summary of fish and water quality data collected during the winter (February 2012), spring (May 2012), and summer (July 2012), as well as bathymetry (2011 and 2012); Acoustic Doppler Current Profiler velocity (ADCP; 2012); and sediment (July 2012).

METHODS

Study Location

The study sites are located along the right descending bank (RDB) and left descending bank (LDB) of the MMR in the open river section. The experimental site is adjacent to Angelo Chute (RM 3.8L - 4.4L), and the control is adjacent to Thompson Bend (RM 18.0R - 19.0R) (Figures 2 and 3). The control dike field was chosen because: 1) no modifications to the dikes are anticipated to be made during the two years of sampling; 2) the dikes are on the inside of a bend similar to the experimental

Figure1. Location of the Middle Mississippi River, which extends from the confluence of the Missouri River to the confluence of the Ohio River.

site; and 3) the dike field is the closest dike field to the experimental site that meets the first two criteria. The structures within both sites were constructed at different times (Table 1). For the experimental site, the bankside portion of the notched dike at RM 4.4L was constructed in 1980. Subsequently the dike was lengthened in 2009 extending the dike toward the navigation channel and the notch was established. The W-dike at RM 4.2L was constructed in 2010. The MRS were also constructed in 2010. At the control site, the three traditional dikes were constructed in 1985 and 1986.

Table 1. The location and construction date and height for structures within the experimental and control survey sites.

Structure	Location	Construction Date	Construction Height (ft. NGVD)
Experimental Site			
Bank side of Notched dike	4.4L	1980	296 - 290
Navigation side of Notched dike	4.4L	2009	296 - 290
W-dike	4.2L	2010	291 - 297
MRS	4.0L	2010	296
Control Site			
Dike 19.0	19.0R	1985	305 - 292
Dike 18.5	18.5R	1985	304 - 294
Dike 18.4	18.4R	1985	301 - 292

Photo 1. View of Multiple Round Point Structures (MRS) looking downstream.

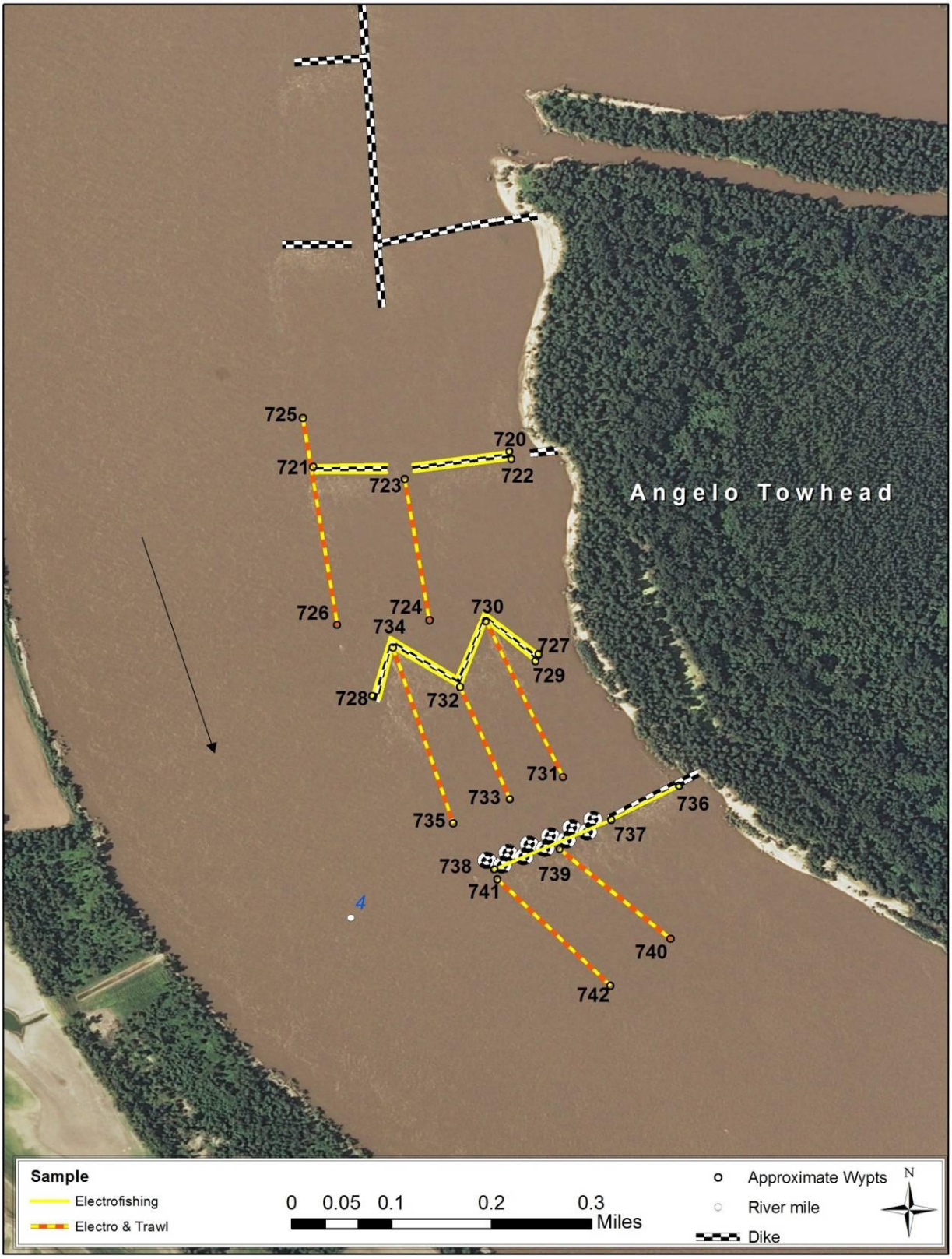

Figure 2. Location of the experimental site, adjacent to Angelo Chute at RM 3.8L - 4.4L. Approximate electrofishing and trawling transect positions are indicated. Numbers represent GPS waypoints.

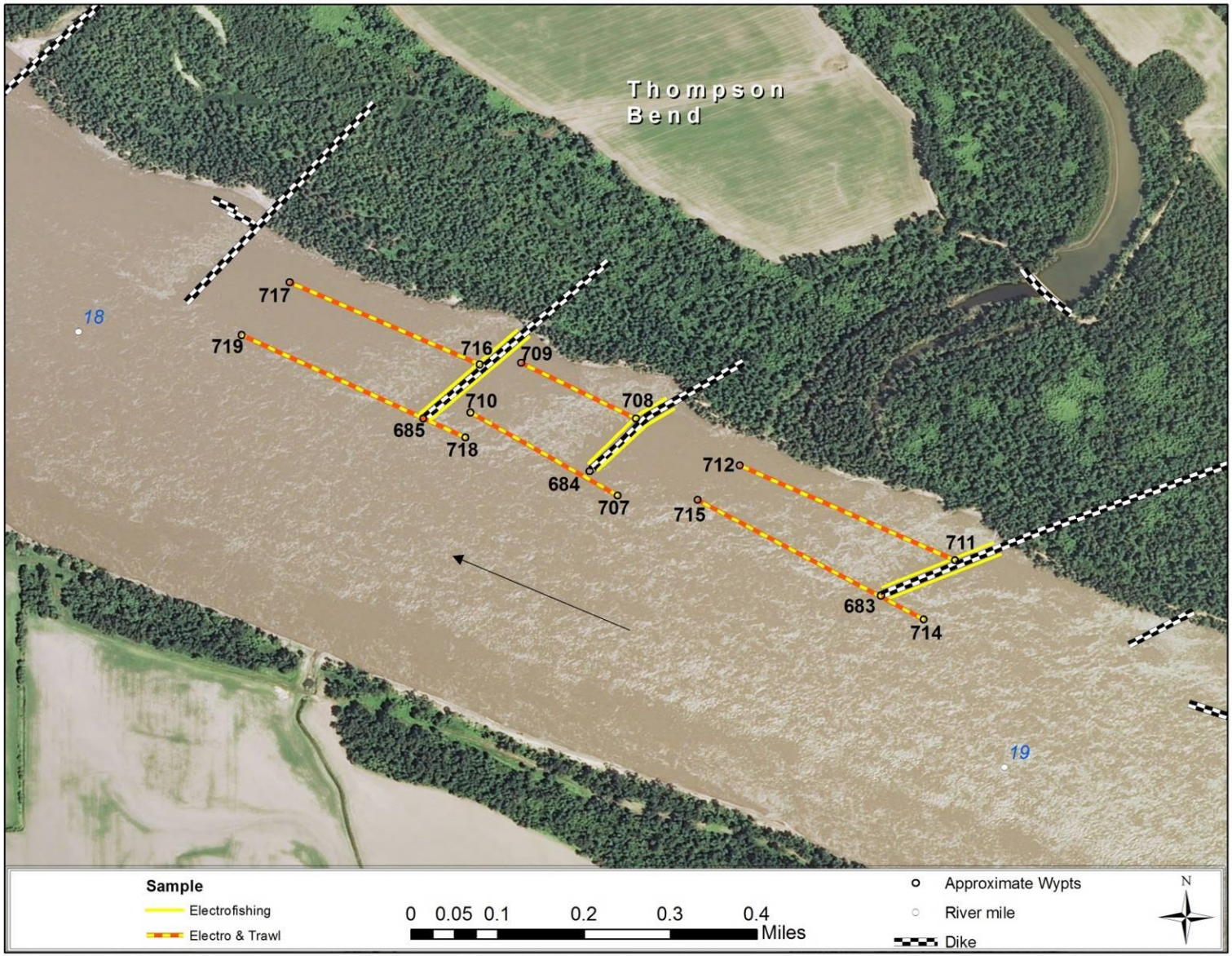

Figure 3. Location of the control site, adjacent to Thompson Bend at RM 18.0R - 19.0R. Approximate electrofishing and trawling transect positions are indicated. Numbers represent GPS waypoints.

Photo 2. Aerial view of the experimental site, taken on 5 November 2012, showing the MRS, W-dike, and notched dike.

Sampling Schedule and Locations

Sampling is scheduled to occur each season (winter, spring, summer, and fall) for two years post construction pending required funding, when river levels are at or below the top of the experimental site structures. This river level occurs at approximately 19.0' stage on the Birds Point gage on the MMR or 23' stage on the Cairo gage on the Ohio River. This water level was initially determined by the design height of the structure, and refined by observing the exposure of the structures from photos and site visits at known river levels.

Fish sampling procedures are modified from those used by the Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) Long Term Resource Monitoring (Gutreuter et al. 1995). A multi-method (i.e., daytime electrofishing and benthic trawling) approach was used to increase the likelihood of sampling a larger portion of the fish community in the survey area (Sheehan and Rasmussen 1993). A total of 25 daytime electrofishing transects and 13 trawling transects using the mini-Missouri otter trawl (Herzog et al. 2009) were scheduled for each sampling period (Figures 2 and 3). Transect locations were chosen in order to explore the unique habitats created by each

structure. Unique identification codes (Sample IDs) were assigned to each transect for data management purposes (Tables 2 and 3). For example, GCD18.4ED indicates a sample taken at the Greenfield Bend project (G), at the control site (C), at dike structure 18.4 (D18.4), using electrofishing (E), on the downstream side of the dike (D).

Fish, which were identifiable in the field, were identified to species level, measured to the nearest millimeter, and released near the collection site. All other fishes were fixed in 10% formalin, and returned to the laboratory for preservation in 70% ethanol, identification and measurement. Additionally, water quality data, (pH, conductivity, water temperature, dissolved oxygen concentration, velocity, and Secchi visibility) were collected near the midpoint of transects.

Table 2. Identification codes used to generate Sample IDs for each scheduled transect.

Study Site	Group	Structure	Sample Method	Location
G - Greenfield Bend	**E** - Experimental **C** - Control	**D19.0** - Dike 19.0R **D18.5** - Dike 18.5R **D18.4** - Dike 18.4R **DN** - Notched dike **DW** - W-dike **MR** - MRS structures **DM** - Dike bankside of MRS	**T** - Trawl **E** - Electrofish	**U** - Upstream **D** - Downstream **B** - Bank **M** - Middle **N** - Navigation

Photo 3. Aerial view of the W-Dike taken on 24 September 2012 during low water conditions. Notice the large area of accretion upstream and downstream of the structure.

Table 3. Sample IDs for Greenfield Bend innovative structures fish sampling. Within each Sample ID column, IDs are in the order that sampling was scheduled to occur.

Structure		Location	Sample ID	
			Electrofish	Trawl
Control	Dike 1	19.0R	GCD19.0ED GCD19.0EU GCD19.0EM GCD19.0EN	GCD19.0TM GCD19.0TN
	Dike 2	18.5R	GCD18.5ED GCD18.5EU GCD18.5EM GCD18.5EN	GCD18.5TM GCD18.5TN
	Dike 3	18.4R	GCD18.4ED GCD18.4EU GCD18.4EM GCD18.4EN	GCD18.4TM GCD18.4TN
Experimental	Notched dike	4.4L	GEDNED GEDNEU GEDNEM GEDNEN	GEDNTM GEDNTN
	W Dike	4.2L	GEDWED GEDWEU GEDWEB GEDWEM GEDWEN	GEDWTB GEDWTM GEDWTN
	Stub Dike	4.0L (adjacent to MRS)	GEDMED	
	MRS	4.0L	GEMRED GEMREM GEMREN	GEMRTM GEMRTN

Electrofishing

Daytime electrofishing (120 DC pulse) was conducted at each structure. For the notched and un-notched dikes, four electrofishing transects were scheduled: one adjacent to the downstream rock face; one adjacent to the upstream rock face; and one each perpendicular to the middle of the dike and off of the navigation tip (Figures 2 and 3). For the W-dike, five electrofishing transects were scheduled: one adjacent to the upstream rock face; one adjacent to the downstream rock face; and one each perpendicular to the W-dike downstream off of the bank leg, the middle leg, and the navigation leg (Figure 2). At the MRS, three electrofishing

transects were scheduled: one adjacent to the downstream rock face; and one each perpendicular to the middle and the navigation portion of the structure. The MRS upstream rock face was not sampled due to the small nature of the structures, and because the fish were carried away by the current before they could be collected (Figure 2). The stub dike adjacent to the MRS was sampled separately from the MRS to allow for a comparison between the fish communities. A single electrofishing transect was conducted along the downstream rock face (Figure 2).

Trawling

An 8 ft. mini-Missouri otter trawl (Herzog et al. 2009), constructed of a 19.05 mm inner mesh unit enclosed by a 4.76 mm outer mesh unit was used. The trawl was attached to the bow of the boat with at least 22.9 m (75') towlines to ensure that the trawl stayed on the bottom during sampling (Herzog et al. 2005). The trawling transects followed the same path as the perpendicular downstream electrofishing runs. Navigation side trawling transects began above the navigation tip of the structures so that the net would be fully deployed when it passed the structure. Trawls downstream of the middle of the structures began by placing the net on the edge of the rock structure (Figures 2 and 3).

Water Quality

Water quality data was collected near the center of electrofishing transects, prior to fish collection in that area. A HydroLab unit was used to collect pH, conductivity (µS/cm), water temperature (˚C), and dissolved oxygen (mg/l) approximately 30-61 cm (1-2') from the surface. Turbidity (cm) was recorded using a Secchi disk. Water velocity (m/sec) was recorded at the transects nearest to the bank and navigation areas of the structures.

Sediment

Sediment samples were collected using a Ponar grab sampler in transects around the structures in each of the fields. Sediments were classified into fines, sand, gravel, or cobble assigned a size class of fine/small, medium, or coarse/large.

Bathymetry

To characterize the river bottom, bathymetric data were gathered using both channel cross-section (single-beam) and multiple transducer sweep (multi-beam) surveys. The single beam survey followed pre-existing survey transects that incorporate overlapping transects to validate data by comparing adjacent soundings from different transects. Utilizing pre-existing transects allows for comparison between surveys collected on different dates. These surveys used a boat mounted acoustic echo sounder to measure depth, a differential GPS to provide accurate position, and a computer to time-tag and record the depth and position data. All components were configured prior to the survey to reflect the particular survey vessel, sensor type, and survey.

Photo 4. Aerial view of the W-Dike and MRS structures taken on 24 September 2012 during low water conditions. Notice the missing sections of rock within the W-Dike. Although not designed into the structure, these areas allow additional scour to occur.

RESULTS

Sampling Dates

During the first year of post-construction sampling, fish assemblage and water quality were sampled during winter (27-28 February 2012), spring (29-30 May 2012), and summer (23-24 July 2012).

Bathymetry

Preliminary bathymetric surveys of the W-dike and MRS were conducted on 8 September 2011. The bottom of the "W" points upstream and scour holes have formed within each "V" segment, as well as off of the bank and navigation legs (Figures 4-5). A large depositional area has formed below the middle leg, between the large scour holes. Several small scour holes have formed downstream of the MRS structure (Figure 5). On 25 July 2012, another bathymetric survey was conducted, but water levels were too low to survey most of the structures. Scour holes are shown downstream of the W-dike (Figure 6). An updated bathymetric survey was conducted on 16 January 2013 (Figure 7). Field observations indicate that a scour hole exists downstream of the notched dike and each of the control dikes, along with a sediment deposition zone a bit farther downstream. There is a much larger deposition zone with a higher maximum elevation behind the notched dike than the control dikes. A bathymetric survey of the control site is shown in Figure 8. Each structure presents areas of diverse local bathymetric habitat.

Photo 5. Area of gravel deposition at RM 17.0R, approximately 1.5 to 2.0 miles downstream from the control site, taken on 24 September 2012 during low water conditions.

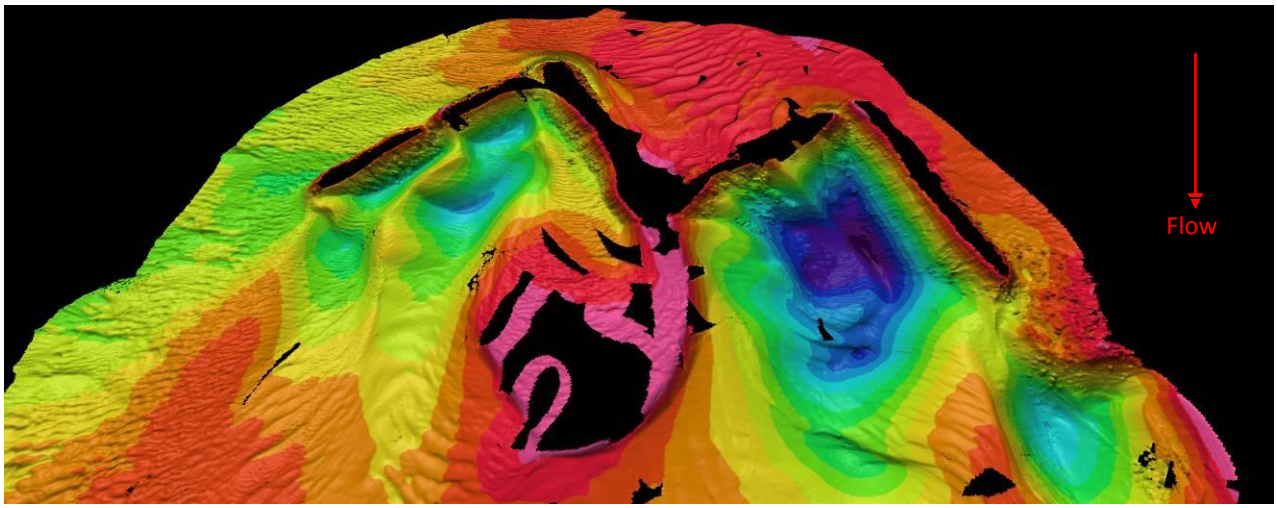

Figure 4. Three dimensional representation of the bathymetry of the W-dike located at MMR RM 4.2L on 8 September 2011. Cooler colors indicate deeper areas, while warmer colors indicate shallower areas.

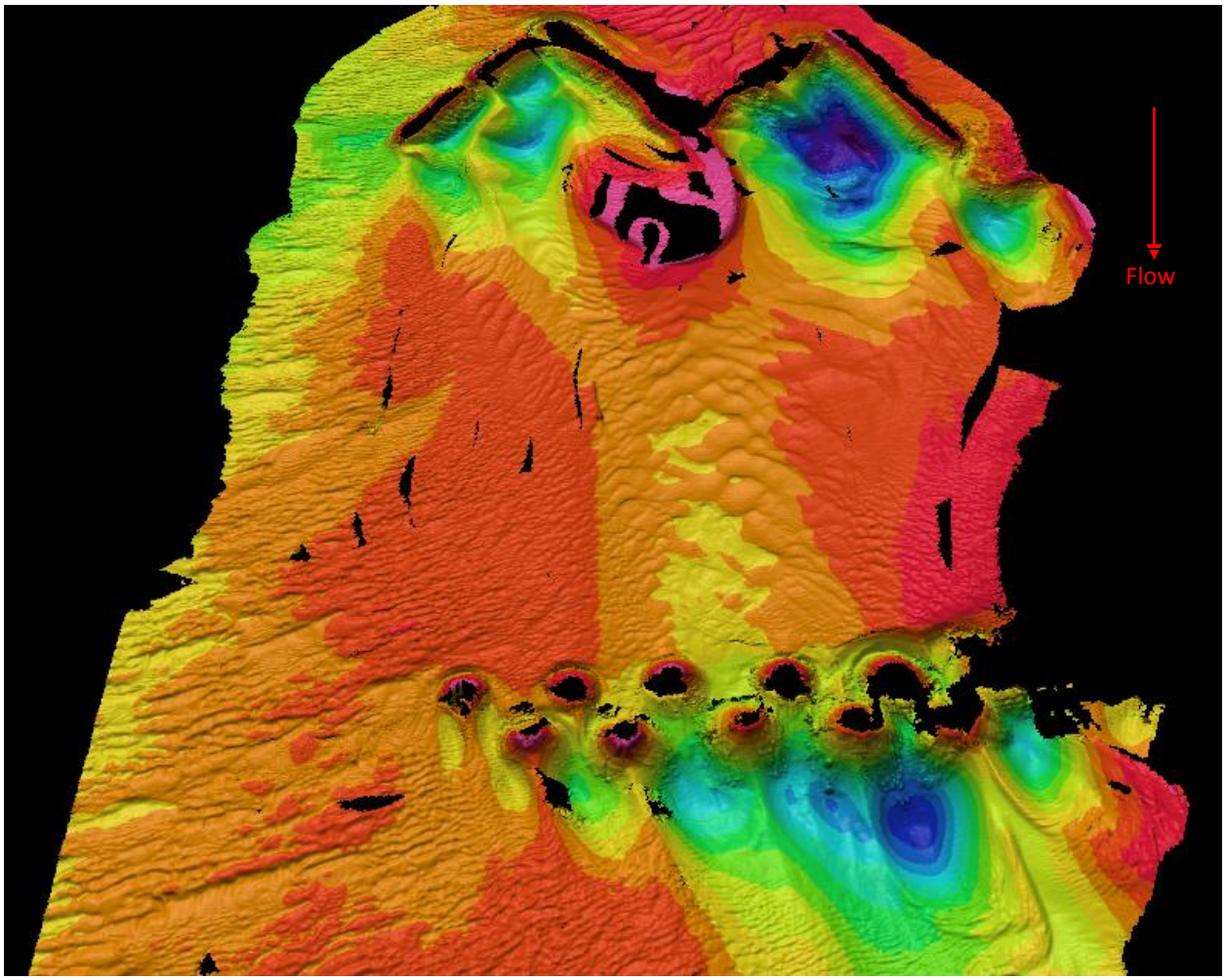

Figure 5. Three dimensional representation of the bathymetry of the W-dike and MRS structures located at MMR RM 4.0L to 4.2L on 8 September 2011.

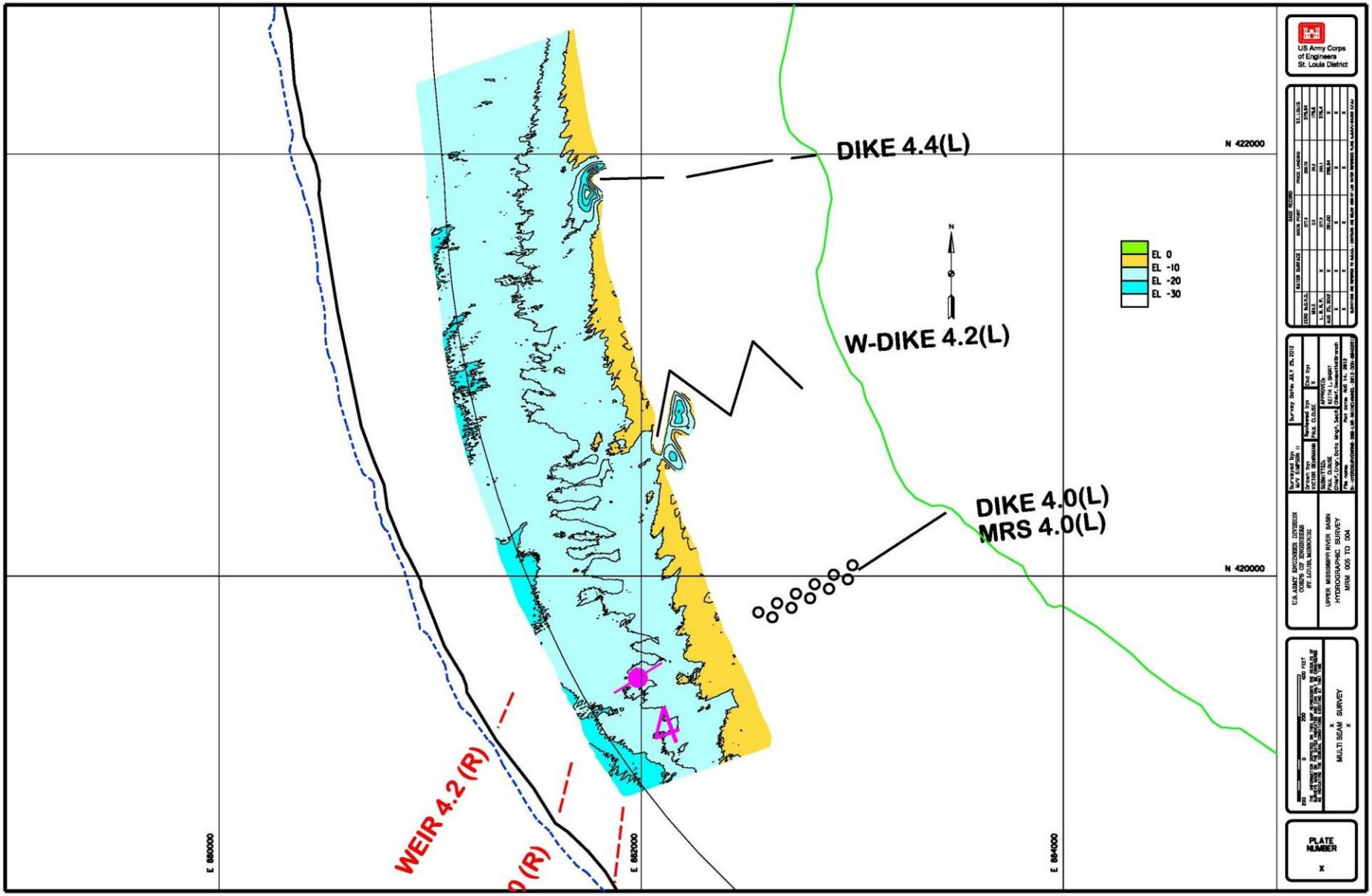

Figure 6. Bathymetric survey of the innovative structures at the experimental site located at MMR RM 4.0L to 4.2L on 25 July 2012. Low water levels prevented suitable surveying over most of the structures.

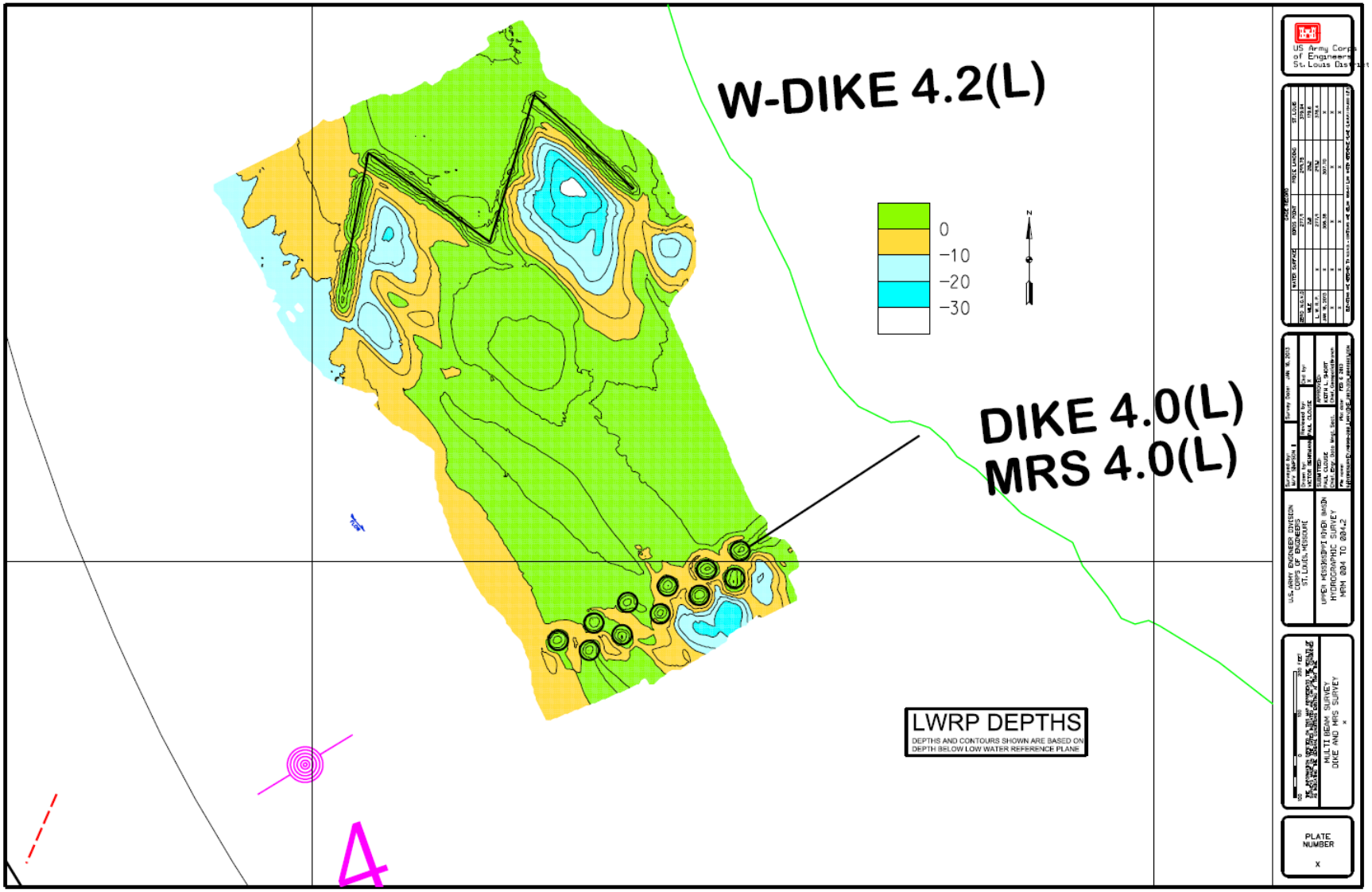

Figure 7. Bathymetric survey of the innovative structures at the experimental site located at MMR RM 4.0L to 4.2L on 16 January 2013.

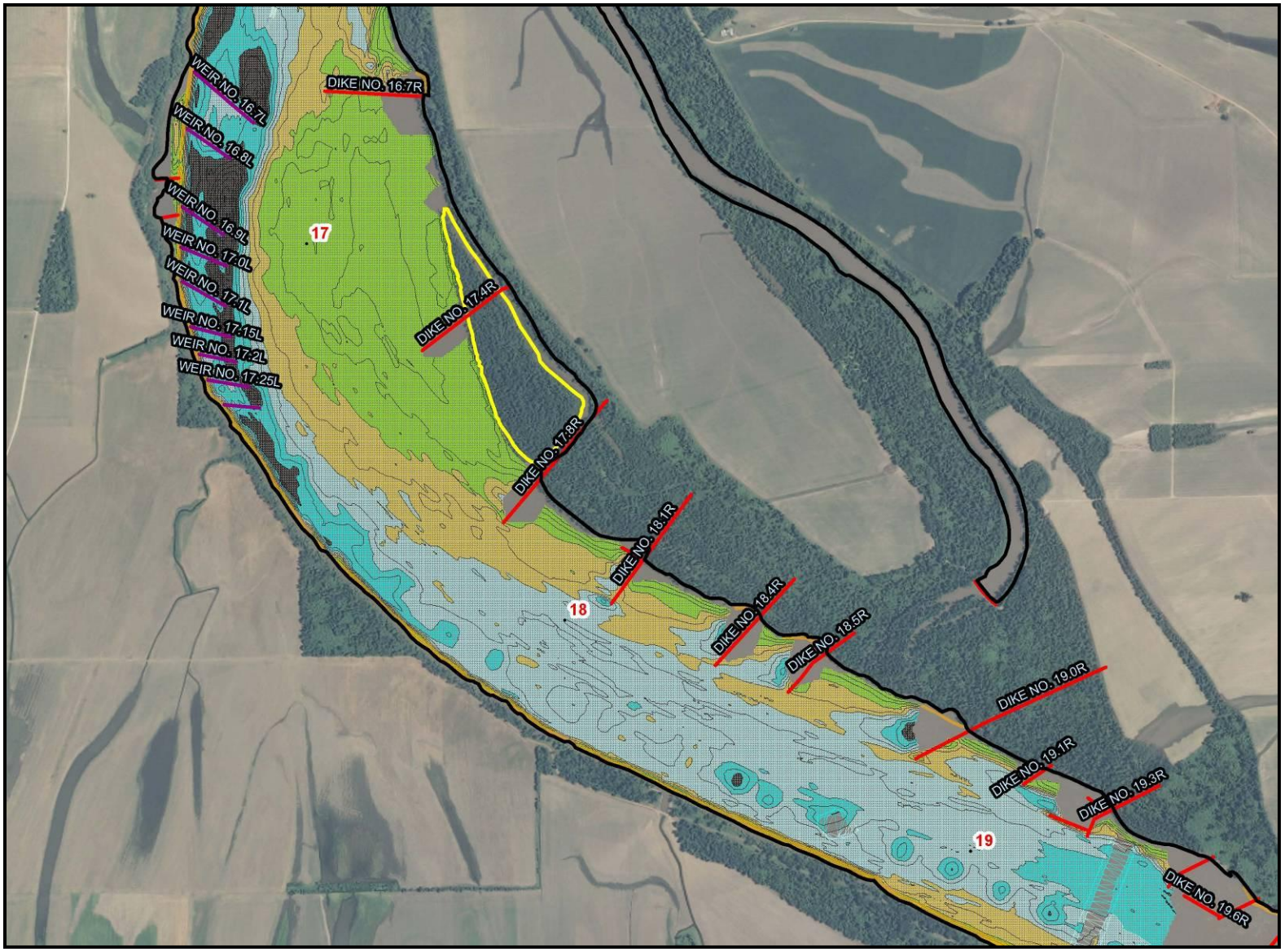

Figure 8. Bathymetric survey of the three traditional un-notched dikes at the control site located near RM 18.0R-19.0R (date unknown).

Sediment

Sediment sampling revealed that the river bed is composed primarily of fine sand at the experimental site (Figure 9); and fine sediment at the control site with a mixture of sand/gravel near the navigation region (Figure 10).

ADCP

Velocity profiles using ADCP were collected on 25 July 2012 at the experimental site (Figure 11). No ADCP surveys were conducted at the control site due to low water conditions.

Winter 2012 - Physicochemical Conditions

The winter sample was conducted on 27-28 February 2012. All 25 electrofishing and 13 trawling transects were completed. During the two day sampling period, water surface elevation rose from 19.78' to 19.98' stage on the Birds Point MO, Mississippi River gage; and from 23.29' to 23.51' stage on the Cairo, IL, Ohio River gage. Approximately $^{1}/_{5}$ the length of each of the control dikes was submerged at the navigation end. At the experimental site, the notched dike was completely visible. Parts of the W-dike were submerged, including the navigation side leg and bankside of the interior V. The MRS were approximately 0.3 m (1') above the water. Conductivity, Secchi visibility, dissolved oxygen concentration, water temperature, water velocity, and pH were fairly consistent between sample locations (Table 4).

Table 4. Range of water quality readings recorded during the winter 2012 samples.

Winter 2012	**Conductivity (µS/cm)**	**Secchi Visibility (cm)**	**D.O. (mg/l)**	**Water Temp. (ºC)**	**Velocity (m/sec)**	**pH**
	545-594	29-33	12.6 - 13.0	6.1-6.5	0.21-0.70	7.1 - 8.3

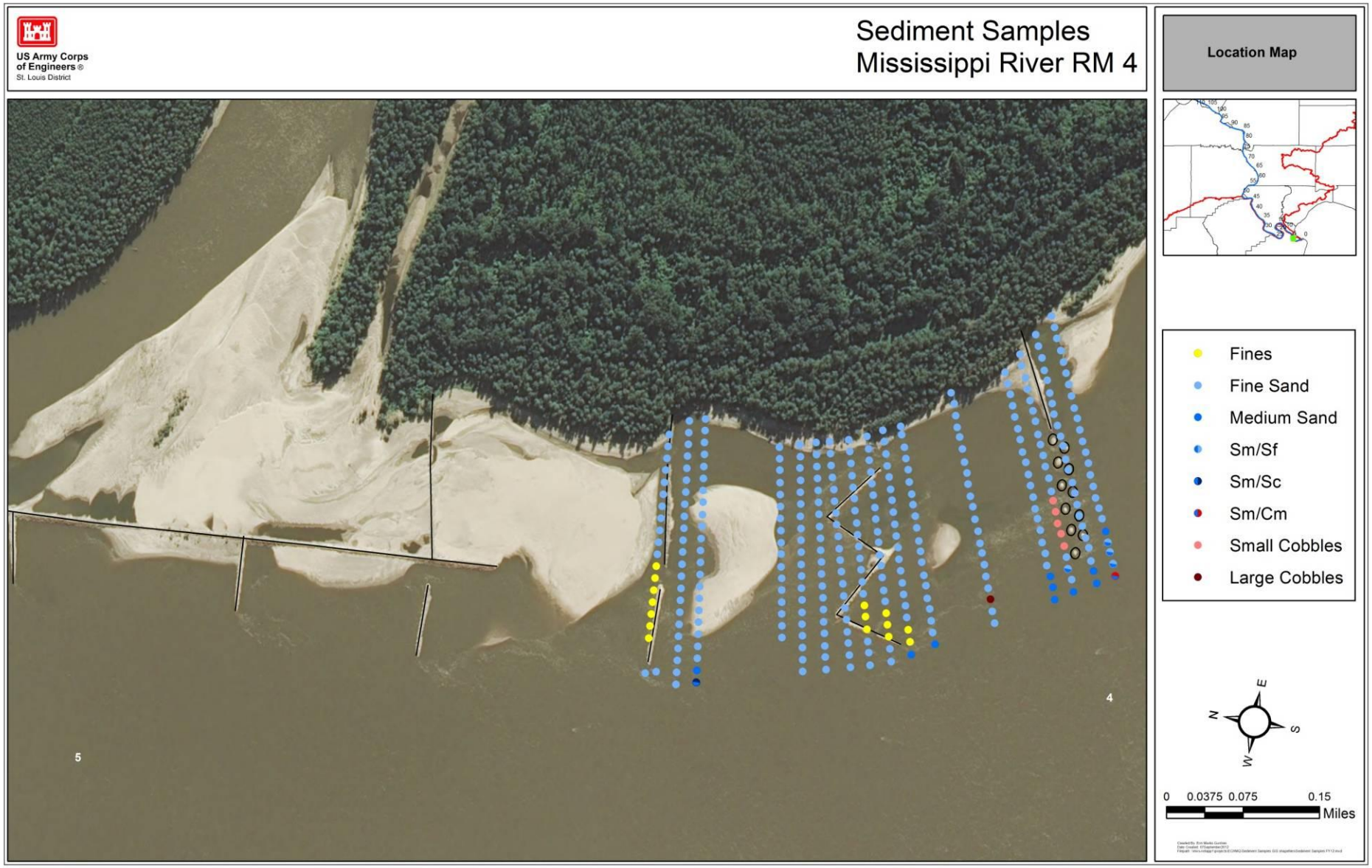

Figure 9. Sediment types collected within the innovative structures experimental site at MMR RM 4.0L to 4.2L in July 2012.

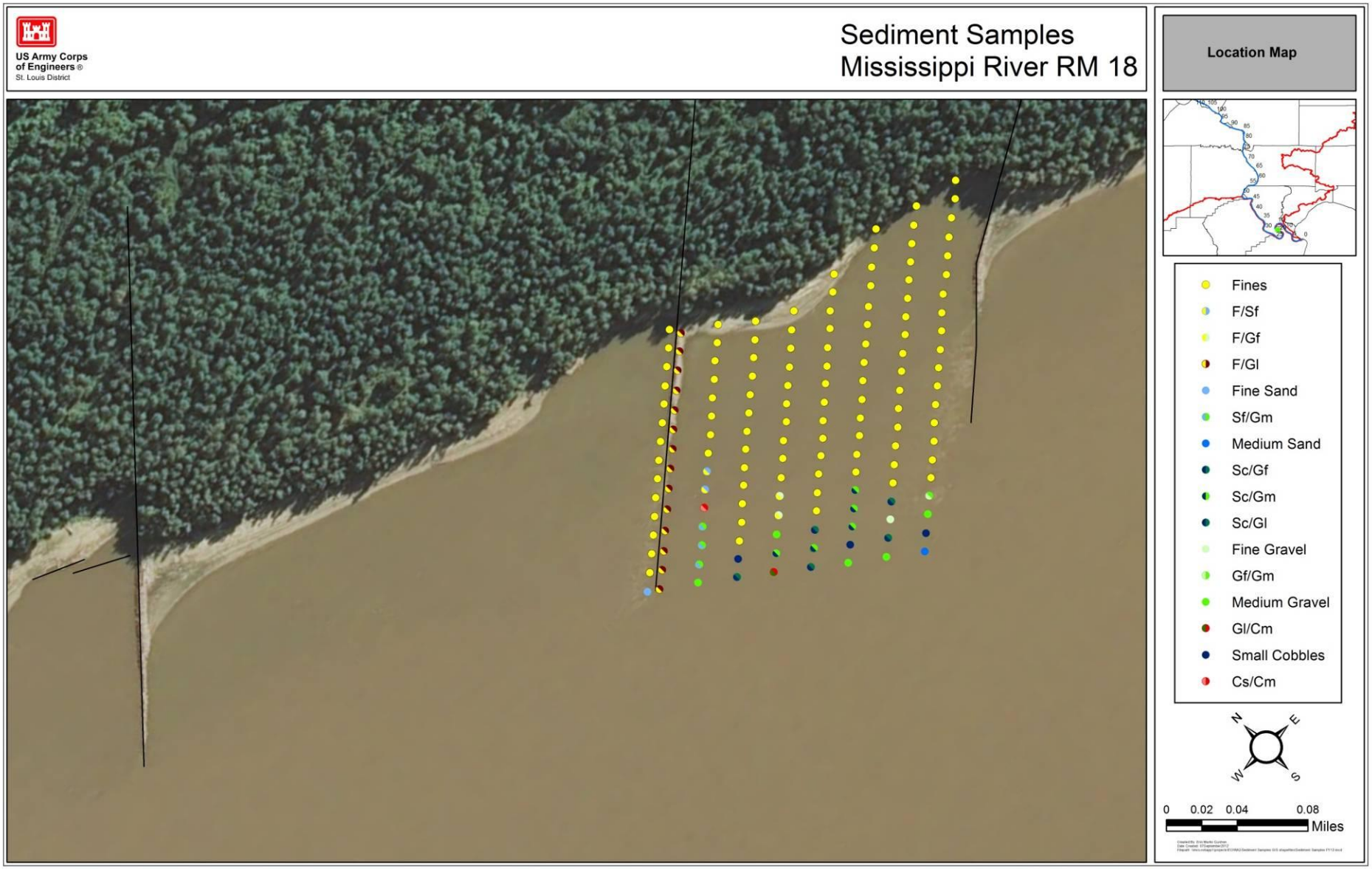

Figure 10. Sediment types collected within the control site at MMR RM 4.0L to 4.2L in July 2012.

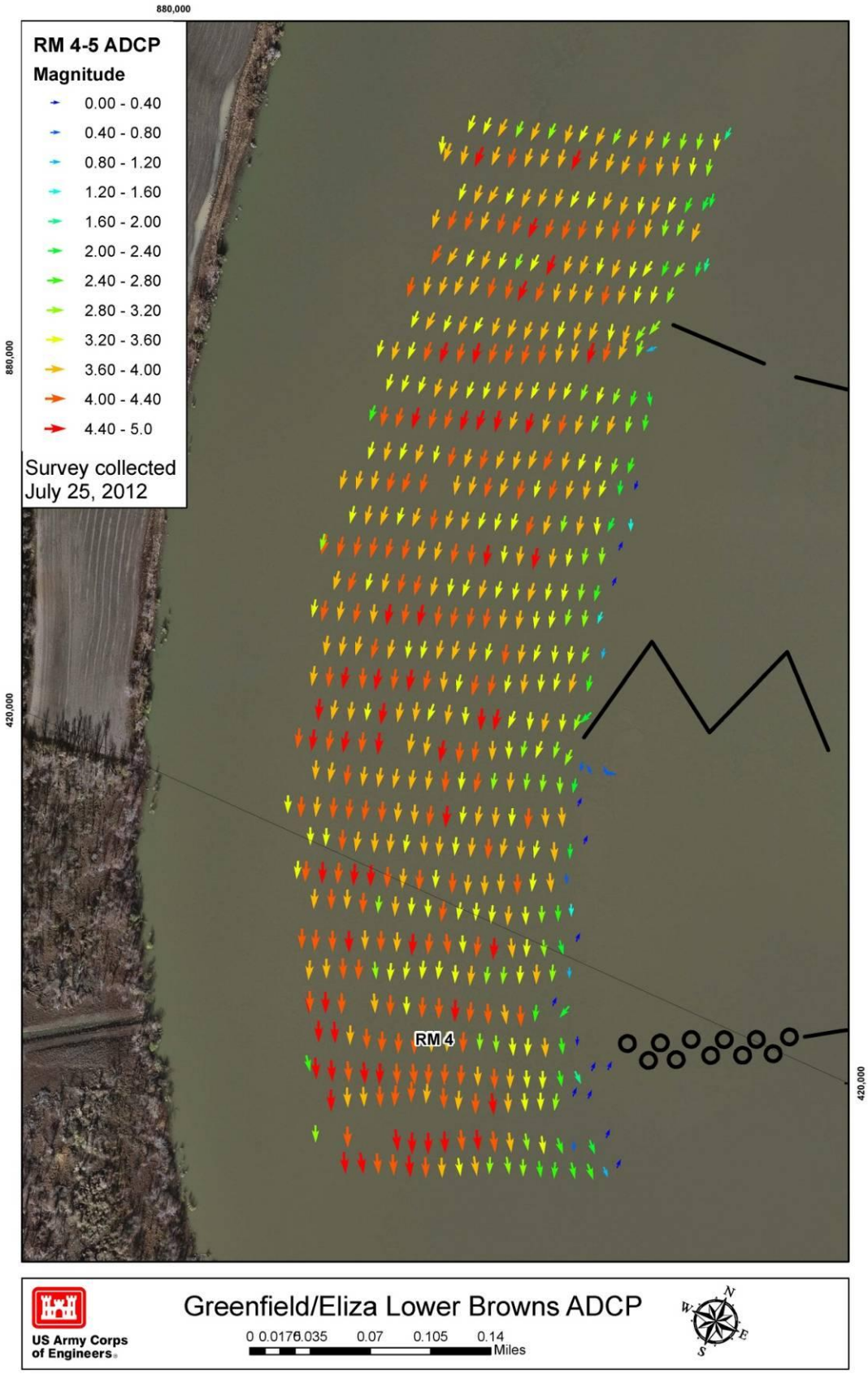

Figure 11. Velocity profile in the vicinity of the innovative structures experimental site at MMR RM 4.0L to 4.2L, collected on 25 July 2012.

Winter 2012 - Fishes Collected

We captured 146 individuals representing eight families and 16 species during the 2012 winter sample (Tables 5 and 6). Dominant fish families collected during the winter sample included Ictaluridae (50.0%), Cyprinidae (18.5%), and Catostomidae (16.4%) (Table 5). Ictalurids were represented by Blue catfish (*Ictalurus furcatus*) and Channel catfish (*Ictalurus punctatus*). Silver carp (*Hypophthalmichthys molitrix*), Common carp (*Cyprinus carpio*), and several Shoal chubs (*Macrhybopsis hyostoma*) comprised the majority of the Cyprinids. Catostomids were represented primarily by Black buffalo (*Ictiobus niger*), River carpsucker (*Carpiodes carpio*), and Smallmouth buffalo (*Ictiobus bubalus*) (Table 6).

The species relative abundance classification system found in Tables 6, 9 and 12 is taken from Steuck et al. (2010), MMR RM 25. The abundance categories consist of stray (X), historical (H), rare (R), uncommon (U), occasional (O), common (C) and abundant (A). Category descriptions can be found in Steuck et al. (2010). Species of interest collected during winter 2012 include a single adult Black crappie captured at the control site.

Species collected only at the experimental site included Shortnose gar (*Lepisosteus platostomus*), Goldeye (*Hiodon alosoides*), Emerald shiner (*Notropis atherinoides*), and Channel catfish. Species collected exclusively at the control site include Bigmouth buffalo (*Ictiobus cyprinellus*), Bluegill (*Lepomis macrochirus*), and Black crappie (*Pomoxis nigromaculatus*).

Of the 146 fishes collected, 43.2% were collected from the experimental site and 56.8% were captured at the control site. Overall, the catch was comprised of 63.7% adults and 36.3% juveniles. Most of the juveniles were Blue catfish, with a few Freshwater drum and a single individual each of Goldeye and Shoal chub (Table 6). All juvenile species were collected using the trawl.

At the experimental site, adults comprised 77.8% of the catch, while juveniles comprised only 22.2%. At the control site, the composition of adults (53.0%) and juveniles (47.0%) was more evenly distributed. Based on these figures, the experimental site may be providing overwintering habitat for adult fishes.

No state or federally listed species were captured during winter 2012.

Table 5. Fish families collected during the winter 2012 sampling trip. Dominant families (> 10%) within each grouping are indicated in bold.

Family	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
	Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Lepisosteidae (gars)	1/0	0/0	1/0	1.6	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.7
Clupeidae (herring)	0/0	1/0	1/0	1.6	5/0	0/0	5/0	6.0	5/0	1/0	6/0	4.1
Hiodontidae (mooneyes)	0/0	0/1	0/1	1.6	0/0	0/0	0/0	0.0	0/0	0/1	0/1	0.7
Cyprinidae (minnows)	**5/0**	**5/0**	**10/0**	**15.9**	**14/0**	**2/1**	**16/1**	**20.5**	**19/0**	**7/1**	**26/1**	**18.5**
Catostomidae (suckers)	**10/0**	**0/0**	**10/0**	**15.9**	**13/0**	**1/0**	**14/0**	**16.9**	**23/0**	**1/0**	**24/0**	**16.4**
Mugilidae (mullets)	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Ictaluridae (catfishes)	**2/0**	**23/13**	**25/13**	**60.3**	**0/0**	**3/32**	**3/32**	**42.2**	**2/0**	**26/45**	**28/45**	**50.0**
Moronidae (temperate basses)	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Centrarchidae (sunfishes)	0/0	0/0	0/0	0.0	4/0	0/0	4/0	4.8	4/0	0/0	4/0	2.7
Sciaenidae (drums)	0/0	2/0	2/0	3.2	1/0	1/6	2/6	9.6	1/0	3/6	4/6	6.8
Subtotal	**18/0**	**31/14**	**49/14**	**100.0**	**37/0**	**7/39**	**44/39**	**100.0**	**55/0**	**38/53**	**93/53**	**100.0**
Total	**63**				**83**				**146**			

Photo 6. Blue catfish, a common recreational species in the MMR.

Table 6. Fish species collected during the winter 2012 sampling trip. Dominant families and species (> 10% of total catch) within the sample are indicated in bold. Species collection by gear type is also indicated.

Family	Common Name	Scientific Name	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
			Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	Shovelnose sturgeon (C)	*Scaphirhynchus platorynchus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Lepisosteidae (gars)	Spotted gar (U)	*Lepisosteus oculatus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Longnose gar (O)	*Lepisosteus osseus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Shortnose gar (A)	*Lepisosteus platostomus*	1/0	0/0	1/0	1.6	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.7
Clupeidae (herring)	Skipjack herring (O)	*Alosa chrysochloris*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Gizzard shad (A)	*Dorosama cepedianum*	0/0	1/0	1/0	1.6	5/0	0/0	5/0	6.0	0/0	1/0	6/0	4.1
	Threadfin shad (O)	*Dorosoma petenense*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Hiodontidae (mooneyes)	Goldeye (C)	*Hiodon alosoides*	0/0	0/0	0/1	1.6	0/0	0/0	0/0	0.0	0/0	0/1	0/1	0.7
Cyprinidae (minnows)	Silver carp (A)	*Hypophthalmichthys molitrix*	2/0	0/0	2/0	3.2	**10/0**	**0/0**	**10/0**	**12.0**	2/0	0/0	12/0	8.2
	Red shiner (C)	*Cyprinella lutrensis*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Common carp (A)	*Cyprinus carpio*	2/0	0/0	2/0	3.2	0/0	0/0	4/0	4.8	2/0	0/0	6/0	4.1
	Shoal chub (C)	*Macrhybopsis hyostoma*	0/0	5/0	5/0	7.9	0/0	2/1	2/1	3.6	0/0	7/1	7/1	5.5
	Silver chub (O)	*Macrhybopsis storeriana*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Emerald shiner (A)	*Notropis atherinoides*	1/0	0/0	0/0	1.6	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.7
	River shiner (C)	*Notropis blennius*	0/0	0/0	1/0	1.6	4/0	0/0	0/0	0.0	1/0	0/0	1/0	0.7
Catostomidae (suckers)	River carpsucker (C)	*Carpiodes carpio*	3/0	0/0	3/0	4.8	1/0	1/0	2/0	2.4	3/0	1/0	5/0	3.4
	Quillback (U)	*Carpiodes cyprinus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Blue sucker (O)	*Cycleptus elongatus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Smallmouth buffalo (C)	*Ictiobus bubalus*	4/0	0/0	4/0	6.3	1/0	0/0	1/0	1.2	4/0	0/0	5/0	3.4
	Bigmouth buffalo (O)	*Ictiobus cyprinellus*	0/0	0/0	0/0	0.0	2/0	0/0	2/0	2.4	0/0	0/0	2/0	1.4
	Black buffalo (O)	*Ictiobus niger*	3/0	0/0	3/0	4.8	**9/0**	**0/0**	**9/0**	**10.8**	3/0	0/0	12/0	8.2
	Shorthead redhorse (O)	*Moxostoma macrolepidotum*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Mugilidae (mullets)	Striped mullet (X)	*Mugil cephalus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Ictaluridae (catfishes)	**Blue catfish (C)**	***Ictalurus furcatus***	**2/0**	**1/0**	**3/13**	**25.4**	**0/0**	**3/32**	**3/32**	**42.2**	**2/0**	**4/45**	**6/45**	**34.9**
	Channel catfish (A)	***Ictalurus punctatus***	**0/0**	**22/0**	**22/0**	**34.9**	0/0	0/0	0/0	0.0	**0/0**	**22/0**	**22/0**	**15.1**
	Freckled madtom (O)	*Noturus nocturnus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Flathead catfish (C)	*Pylodictis olivaris*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Moronidae (temperate basses)	White bass (C)	*Morone chrysops*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Centrarchidae (sunfishes)	Green sunfish (C)	*Lepomis cyanellus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Bluegill (C)	*Lepomis macrochirus*	0/0	0/0	0/0	0.0	3/0	0/0	3/0	3.6	0/0	0/0	3/0	2.1
	Smallmouth bass (U)	*Micropterus dolomieu*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Black crappie (U)	*Pomoxis nigromaculatus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	1.2	0/0	0/0	1/0	0.7
Sciaenidae (drums)	Freshwater drum (A)	*Aplodinotus grunniens*	0/0	2/0	2/0	3.2	1/0	1/6	2/6	9.6	0/0	3/6	4/6	6.8
Sub-Total			**18/0**	**31/0**	**49/14**	**100.0**	**37/0**	**7/39**	**44/39**	**100.0**	**18/0**	**38/53**	**93/53**	**100.0**
Total			**63**				**83**				**146**			

X - Probably occurs only as a stray from a tributory or inland stocking.
H - Records of occurrence are available, but no collections have been documented in the last ten years.
R - Considered to be rare. Some species in this category may be on the verge of extirpation.
U - Uncommon, does not usually appear in sample collections, populations are small, but the species in this category do not appear to be on the verge of extirpation.
O - Occasionally collected, not generally distributed, but local concentrations may occur.
C - Commonly taken in most sample collections; can make up a large portion of some samples.
A - Abundantly taken in all river surveys.

Photo 7. Smallmouth buffalo (top) and River carpsucker (bottom) were collected from both the experimental and control sites during the winter 2012 sample.

Spring 2012 - Physicochemical Conditions

The spring sample was conducted on 29-30 May 2012. All 25 electrofishing runs and 13 trawling runs were completed, though several were modified/shortened due to shallow water/sandbars. For the two day spring sample, water surface elevations were falling from 12.05' to 11.35' stage on the Birds Point MO, Mississippi River gage; and from 14.74' to 14.00' stage on the Cairo, IL, Ohio River gage.

The sandbar below the notched dike was much larger than during the winter sample, thus the middle trawling and electrofishing runs below the dike (GEDNTM and GEDNEM) were shortened; new waypoints were set (755 and 756). Sandbars had formed directly adjacent to the upstream and downstream W-dike rock. Thus, the middle trawling and electrofishing runs (GEDWTM and GEDWEM) were started downriver at the bottom of the sandbar.

The electrofishing run of the upstream side of the W-dike (GEDWEU) sampled only the navigation side leg; the remainder was covered in sand. The current was very strong along the navigation side leg. The middle of the downstream side of the W-dike was covered in sand; the

remainder was sampled (GEDWED). Additionally, two notches had formed in the upstream points of the W dike. Therefore, the W-dike bank and navigation side trawl runs were started by placing the net as close to the notch as possible.

The MRS were sampled successfully though strong currents made it difficult to collect shocked fish. Midway along the downstream side of the stub dike is a sandbar; thus the electrofishing run was shortened. All control runs were completed without modification. The pH sensor on the HydroLab malfunctioned on 30 May 2012 and readings from this day were discarded. Compared to the winter sampling period, conductivity, Secchi visibility, and dissolved oxygen concentration were lower; water temperature was considerably higher; and velocity and pH were similar (Tables 4 and 7).

Table 7. Range of water quality readings recorded during the spring 2012 samples.

Spring 2012	**Conductivity (µS/cm)**	**Secchi Visibility (cm)**	**D.O. (mg/L)**	**Water Temp. (ºC)**	**Velocity (m/sec)**	**pH**
	358-375	13-25	7.2-7.6	25.8-26.3	0.00-1.80	7.7-8.3

Spring 2012 - Fishes Collected

We captured 284 individuals representing 10 families and 23 species during the 2012 spring sample (Tables 8 and 9). Dominant fish families collected during the spring sample included Ictaluridae (31.7%), Cyprinidae (15.8%), Lepisosteidae (16.2%), Catostomidae (12.7%), and Sciaenidae (12.3%) (Table 8). Ictalurids were represented primarily by Blue catfish and Channel catfish. Shortnose gar comprised the majority of Lepisosteidae. Silver carp and Common carp comprised the majority of the Cyprinids. Catostomids were represented primarily by Smallmouth buffalo and River carpsucker. Sciaenidae is represented entirely by Freshwater drum, the only species in the family in Missouri. While not present in the winter sample, Acipenseridae and Moronidae were collected in the spring sample (Tables 6 and 9).

No species considered stray, historical, rare, or uncommon, based on the species relative abundance classification system used by Steuck et al. (2010), were collected during the spring 2012 sampling period (Table 9).

Species collected only at the experimental site included Emerald shiner, Gizzard shad, Shoal chub, and Shorthead redhorse. Species collected exclusively at the control site include Black buffalo, Bluegill, Freckled madtom, Skipjack herring, and Threadfin shad (Table 9).

Of the 284 fishes collected, 45.4% were collected from the experimental site and 54.6% were captured at the control site. Overall, the catch was comprised of 45.4% adults and 54.6% juveniles. Most of the juveniles were Blue catfish, with a few Goldeye, and a single Longnose gar (Table 9).

At the experimental site, adults comprised 86.0% of the catch, while juveniles comprised only 14.0%. At the control site, the composition of adults was 97.4% and juveniles comprised only 2.6% of the total catch. This differs drastically from the winter control site sample where adults and juveniles were almost evenly distributed (Tables 6 and 9).

No state or federally listed species were captured. However, the Shovelnose sturgeon is listed as a threatened species under the "Similarity of Appearances" provisions of the Endangered Species Act. The listing took place in order to protect the federally endangered pallid sturgeon where the populations of the two species overlap in portions of the Missouri and Mississippi River basins.

Photo 8. An adult shovelnose sturgeon was collected at the experimental site during the spring 2012 sample.

Table 8. Fish families collected during the spring 2012 sampling trip. Dominant families (> 10%) within each grouping are indicated in bold.

Family	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
	Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	1/0	0/0	1/0	0.4	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.4
Lepisosteidae (gars)	**13/0**	**0/0**	**45/1**	**16.2**	**30/1**	**2/0**	**32/1**	**21.3**	**43/1**	**2/0**	**45/1**	**16.2**
Clupeidae (herring)	12/0	0/0	15/0	5.3	3/0	0/0	3/0	1.9	15/0	0/0	15/0	5.3
Hiodontidae (mooneyes)	½	0/0	2/3	1.8	1/1	0/0	1/1	1.3	2/3	0/0	2/3	1.8
Cyprinidae (minnows)	**8/0**	**1/0**	**45/0**	**15.8**	**36/0**	**0/0**	**36/0**	**23.2**	**44/0**	**1/0**	**45/0**	**15.8**
Catostomidae (suckers)	**17/0**	**0/0**	**36/0**	**12.7**	**19/0**	**0/0**	**19/0**	**12.3**	**36/0**	**0/0**	**36/0**	**12.7**
Mugilidae (mullets)	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Ictaluridae (catfishes)	**32/1**	**4/15**	**72/18**	**31.7**	**36/0**	**0/2**	**36/2**	**24.5**	**68/1**	**4/17**	**72/18**	**31.7**
Moronidae (temperate basses)	3/0	0/0	10/0	3.5	7/0	0/0	7/0	4.5	10/0	0/0	10/0	3.5
Centrarchidae (sunfishes)	0/0	0/0	1/0	0.4	1/0	0/0	1/0	0.6	1/0	0/0	1/0	0.4
Sciaenidae (drums)	**19/0**	**0/0**	**35/0**	**12.3**	**16/0**	**0/0**	**16/0**	**10.3**	**35/0**	**0/0**	**35/0**	**12.3**
Subtotal	**106/3**	**5/15**	**111/18**	**100.0**	**149/2**	2/2	**151/4**	**100.0**	**255/5**	**0/17**	**262/22**	**100.0**
Total	**129**				**155**				**284**			

Photo 9. Lepisosteidae (gars) made up approximately 16.2% of the total catch in spring 2012.

Table 9. Fish species collected during the spring 2012 sampling trip. Dominant families and species (> 10% of total catch) within the sample are indicated in bold. Species collection by gear type is also indicated.

Family	Common Name	Scientific Name	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
			Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	Shovelnose sturgeon (C)	*Scaphirhynchus platorynchus*	1/0	0/0	1/0	0.8	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.4
Lepisosteidae (gars)	Spotted gar (U)	*Lepisosteus oculatus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	2/0	0/0	0.0
	Longnose gar (O)	*Lepisosteus osseus*	2/0	0/0	2/0	1.6	2/1	0/0	2/1	1.9	4/1	0/0	4/1	1.8
	Shortnose gar (A)	***Lepisosteus platostomus***	11/0	0/0	11/0	8.5	**28/0**	**2/0**	**30/0**	**19.4**	**39/0**	**0/0**	**41/0**	**14.4**
Clupeidae (herring)	Skipjack herring (O)	*Alosa chrysochloris*	0/0	0/0	0/0	0.0	2/0	0/0	2/0	1.3	2/0	0/0	2/0	0.7
	Gizzard shad (A)	*Dorosama cepedianum*	12/0	0/0	12/0	9.3	0/0	0/0	0/0	0.0	12/0	0/0	12/0	4.2
	Threadfin shad (O)	*Dorosoma petenense*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.6	1/0	0/0	1/0	0.4
Hiodontidae (mooneyes)	Goldeye (C)	*Hiodon alosoides*	1/2	0/0	1/2	2.3	1/1	0/0	1/1	1.3	2/3	0/0	2/3	1.8
Cyprinidae (minnows)	Silver carp (A)	*Hypophthalmichthys molitrix*	3/0	0/0	3/0	2.3	14/0	0/0	14/0	9.0	17/0	0/0	17/0	6.0
	Red shiner (C)	*Cyprinella lutrensis*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Common carp (A)	***Cyprinus carpio***	4/0	0/0	4/0	3.1	**22/0**	**0/0**	**22/0**	**14.2**	26/0	0/0	26/0	9.2
	Shoal chub (C)	*Macrhybopsis hyostoma*	0/0	1/0	1/0	0.8	0/0	0/0	0/0	0.0	0/0	1/0	1/0	0.4
	Silver chub (O)	*Macrhybopsis storeriana*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Emerald shiner (A)	*Notropis atherinoides*	1/0	0/0	1/0	0.8	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.4
	River shiner (C)	*Notropis blennius*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Catostomidae (suckers)	River carpsucker (C)	*Carpiodes carpio*	6/0	0/0	6/0	4.7	2/0	0/0	2/0	1.3	8/0	0/0	8/0	2.8
	Quillback (U)	*Carpiodes cyprinus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Blue sucker (O)	*Cycleptus elongatus*	3/0	0/0	3/0	2.3	2/0	0/0	2/0	1.3	5/0	0/0	5/0	1.8
	Smallmouth buffalo (C)	*Ictiobus bubalus*	7/0	0/0	7/0	5.4	12/0	0/0	12/0	7.7	19/0	0/0	19/0	6.7
	Bigmouth buffalo (O)	*Ictiobus cyprinellus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Black buffalo (O)	*Ictiobus niger*	0/0	0/0	0/0	0.0	3/0	0/0	3/0	1.9	3/0	0/0	3/0	1.1
	Shorthead redhorse (O)	*Moxostoma macrolepidotum*	1/0	0/0	1/0	0.8	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.4
Mugilidae (mullets)	Striped mullet (X)	*Mugil cephalus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Ictaluridae (catfishes)	**Blue catfish (C)**	***Ictalurus furcatus***	**0/1**	**3/15**	**18/16**	**26.4**	8/0	0/2	8/2	6.5	**23/1**	**3/17**	**26/18**	**15.5**
	Channel catfish (A)	***Ictalurus punctatus***	11/0	1/0	12/0	9.3	**18/0**	**0/0**	**18/0**	**11.6**	**29/0**	**1/0**	**30/0**	**10.6**
	Freckled madtom (O)	*Noturus nocturnus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.6	1/0	0/0	1/0	0.4
	Flathead catfish (C)	*Pylodictis olivaris*	6/0	0/0	6/0	4.7	9/0	0/0	9/0	5.8	15/0	0/0	15/0	5.3
Moronidae (temperate basses)	White bass (C)	*Morone chrysops*	3/0	0/0	3/0	2.3	7/0	0/0	7/0	4.5	10/0	0/0	10/0	3.5
Centrarchidae (sunfishes)	Green sunfish (C)	*Lepomis cyanellus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Bluegill (C)	*Lepomis macrochirus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.6	1/0	0/0	1/0	0.4
	Smallmouth bass (U)	*Micropterus dolomieu*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Black crappie (U)	*Pomoxis nigromaculatus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Sciaenidae (drums)	**Freshwater drum (A)**	***Aplodinotus grunniens***	**19/0**	**0/0**	**19/0**	**14.7**	**16/0**	**0/0**	**16/0**	**10.3**	**35/0**	**0/0**	**35/0**	**12.3**
Sub-Total			**106/3**	**5/15**	**111/18**	**100.0**	**149/2**	**2/2**	**151/4**	**100.0**	**255/5**	**7/17**	**262/22**	**100.0**
Total			**129**				**155**				**284**			

X - Probably occurs only as a stray from a tributory or inland stocking.
H - Records of occurrence are available, but no collections have been documented in the last ten years.
R - Considered to be rare. Some species in this category may be on the verge of extirpation.
U - Uncommon, does not usually appear in sample collections, populations are small, but the species in this category do not appear to be on the verge of extirpation.
O - Occasionally collected, not generally distributed, but local concentrations may occur.
C - Commonly taken in most sample collections; can make up a large portion of some samples.
A - Abundantly taken in all river surveys.

Photo 10. Blue suckers were collected at both the experimental and control sites during the spring 2012 sampling trip. Blue suckers are only occasionally collected in MMR samples.

Summer 2012 - Physicochemical Conditions

The summer sample was conducted on 23-24 July 2012. Twenty-two of the 25 electrofishing transects and 10 of 13 trawling transects were completed. During the two day sampling period, water surface elevation rose from 7.24' to 8.30' stage on the Birds Point MO, Mississippi River gage; and from 10.00' to 11.17' stage on the Cairo, IL, Ohio River gage.

The sandbar adjacent to the experimental notched dike was exposed, thus the middle trawling and electrofishing transects below the dike (GEDNTM and GEDNEM) were not conducted. The sandbar also prevented sampling along the upstream and downstream portion of the notched dike bankside of the notch. At the W-dike, the bank and middle trawl (GEDWTB and GEDNTM) and electrofishing transects (GEDWEB and GEDNEM) were not collected due to shallow water/sandbars. A large sandbar also occurred downstream of the MRS structures. Only a portion of the MRS structures and stub dike could be sampled. All control runs were completed, although several transects were modified/shortened due to shallow water conditions. Water quality parameters were collected at GEDWTN, GEMRTM, GEMRTN, GEDNEN, GCD19.0TM, GCD18.5TM, and GCD18.4TM. The range of water quality readings recorded during the summer 2012 samples is presented in Table 10.

Table 10. Range of water quality readings recorded during the summer 2012 samples.

Summer 2012	Conductivity (µS)	Secchi Visibility (cm)	D.O. (mg/L)	Water Temp. (ºC)	Velocity (m/sec)	pH
	267-402	23-30	6.9-9.4	30.9-32.7	0.22-1.34	5.6-7.6

Summer 2012 - Fishes Collected

We captured 1898 individuals representing 10 families and 28 species during the summer 2012 sample (Tables 11 and 12)*. Dominant fish families collected during the summer sample included Cyprinidae (29.1%), and Sciaenidae (48.9%) (Table 11)*. Cyprinids were represented primarily by Emerald shiners and Silver chub. Sciaenidae is represented entirely by Freshwater drum. Families not previously collected include Mugilidae, which was represented by a single Striped mullet (Tables 6, 9, and 12).

Species considered stray, historical, rare, or uncommon, based on the species relative abundance classification system used by Steuck et al. (2010), collected during the summer 2012 sampling period include Spotted gar (*Lepisosteus oculatus*), Quillback (*Carpiodes cyprinus*), Striped mullet (*Mugil cephalus*), Smallmouth bass (*Micropterus dolomieu*), and Black crappie (*Pomoxis nigromaculatus*) (Table 12).

Species collected only at the experimental site included Longnose gar, River shiner, Quillback, and Green sunfish. Species collected exclusively at the control site include Spotted gar, Striped mullet, Bluegill, and Smallmouth bass (Table 12).

Of the 1898 fishes collected, 29.5% were collected from the experimental site and 70.5% were captured at the control site. Overall, the catch was comprised of 23.4% adults and 76.6% juveniles. Most of the juveniles were Freshwater drum, Silver chub, and Emerald shiner, (Table 12).

At the experimental site, adults comprised 44.9% of the catch, while juveniles comprised 55.1%. At the control site, the composition of adults was 14.4% and juveniles comprised 85.6% of the total catch*.

No state or federally listed species were captured.

Table 11. Fish families collected during the summer 2012 sampling trip. Dominant families (> 10%) within each grouping are indicated in bold.*

Family	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
	Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Lepisosteidae (gars)	16/3	0/0	16/3	3.4	18/1	0/0	18/1	1.4	34/4	0/0	34/4	2.0
Clupeidae (herring)	28/6	0/0	28/6	6.1	56/66	0/0	56/66	9.1	84/72	0/0	84/72	8.2
Hiodontidae (mooneyes)	1/9	0/0	1/9	1.8	1/4	0/4	1/8	0.7	2/13	0/4	2/17	1.0
Cyprinidae (minnows)	**153/35**	**3/12**	**156/47**	**36.3**	**54/123**	**2/171**	**56/294**	**26.1**	**207/158**	**5/183**	**212/341**	**29.1**
Catostomidae (suckers)	5/49	0/1	5/50	9.8	11/5	1/1	12/6	1.3	16/54	1/2	17/56	3.8
Mugilidae (mullets)	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1	1/0	0/0	1/0	0.1
Ictaluridae (catfishes)	20/1	1/5	21/6	4.8	26/1	6/55	32/56	6.6	46/2	7/60	53/62	6.1
Moronidae (temperate basses)	8/0	0/0	8/0	1.4	3/0	0/0	3/0	0.2	11/0	0/0	11/0	0.6
Centrarchidae (sunfishes)	1/0	0/0	1/0	0.2	1/1	0/0	1/1	0.1	2/1	0/0	2/1	0.2
Sciaenidae (drums)	**15/20**	**0/167**	**15/187**	**36.1**	**13/14**	**0/700**	**13/714**	**54.3**	**28/34**	**0/867**	**28/901**	**48.9**
Subtotal	**247/123**	**4/185**	**251/308**	**100.0**	**184/215**	**9/931**	**193/1146**	**100.0**	**431/338**	**13/1116**	**444/1454**	**100.0**
Total	**559**				**1339**				**1898**			

*Approximately 900 additional (juvenile) fishes from the summer sample were reported after this document was complete. The vast majority were from the W-Dike, and were identified as Channel shiner, Silver chub, and Emerald shiner.

Photo 11. Emerald shiner, a very abundant minnow in the MMR.

Table 12. Fish species collected during the summer sampling trip. Dominant families and species (> 10% of total catch) within the sample are indicated in bold. Species collection by gear type is also indicated*.

Family	Common Name	Scientific Name	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
			Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	Shovelnose sturgeon (C)	*Scaphirhynchus platorynchus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Lepisosteidae (gars)	Spotted gar (U)	*Lepisosteus oculatus*	0/0	0/0	0/0	0.0	0/1	0/0	0/1	0.1	0/1	0/0	0/1	0.1
	Longnose gar (O)	*Lepisosteus osseus*	1/3	0/0	1/3	0.7	0/0	0/0	0/0	0.0	1/3	0/0	1/3	0.2
	Shortnose gar (A)	*Lepisosteus platostomus*	15/0	0/0	15/0	2.7	18/0	0/0	18/0	1.3	33/0	0/0	33/0	1.7
Clupeidae (herring)	Skipjack herring (O)	*Alosa chrysochloris*	0/1	0/0	0/1	0.2	2/1	0/0	2/1	0.2	2/2	0/0	2/2	0.2
	Gizzard shad (A)	*Dorosoma cepedianum*	5/0	0/0	5/0	0.9	3/1	0/0	3/1	0.3	8/1	0/0	8/1	0.5
	Threadfin shad (O)	*Dorosoma petenense*	23/5	0/0	23/5	5.0	51/64	0/0	51/64	8.6	74/69	0/0	74/69	7.5
Hiodontidae (mooneyes)	Goldeye (C)	*Hiodon alosoides*	1/9	0/0	1/9	1.8	1/4	0/4	1/8	0.7	2/13	0/4	2/17	1.0
Cyprinidae (minnows)	Silver carp (A)	*Hypophthalmichthys molitrix*	11/0	0/0	11/0	2.0	3/0	0/0	3/0	0.2	14/0	0/0	14/0	0.7
	Red shiner (C)	*Cyprinella lutrensis*	19/0	0/0	19/0	3.4	0/0	0/0	0/0	0.0	19/0	0/0	19/0	1.0
	Common carp (A)	*Cyprinus carpio*	2/0	0/0	2/0	0.4	3/0	1/0	4/0	0.3	5/0	1/0	6/0	0.3
	Shoal chub (C)	*Macrhybopsis hyostoma*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Silver chub (O)	***Macrhybopsis storeriana***	1/0	0/6	1/6	1.3	**0/0**	**0/171**	**0/171**	**12.8**	1/0	0/177	1/177	9.4
	Emerald shiner (A)	***Notropis atherinoides***	**120/34**	**2/6**	**122/40**	**29.0**	**48/123**	**1/0**	**49/123**	**12.8**	**168/157**	**3/6**	**171/163**	**17.6**
	River shiner (C)	*Notropis blennius*	0/1	1/0	1/1	0.4	0/0	0/0	0/0	0.0	0/1	1/0	1/1	1.0
Catostomidae (suckers)	River carpsucker (C)	*Carpiodes carpio*	2/48	0/1	2/49	9.1	2/5	0/1	2/6	0.6	4/53	0/2	4/55	3.1
	Quillback (U)	*Carpiodes cyprinus*	0/1	0/0	0/1	0.2	0/0	0/0	0/0	0.0	0/1	0/0	0/1	0.1
	Blue sucker (O)	*Cycleptus elongatus*	1/0	0/0	1/0	0.2	0/0	1/0	1/0	0.1	1/0	1/0	2/0	0.1
	Smallmouth buffalo (C)	*Ictiobus bubalus*	1/0	0/0	1/0	0.2	8/0	0/0	8/0	0.6	9/0	0/0	9/0	0.5
	Bigmouth buffalo (O)	*Ictiobus cyprinellus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
	Black buffalo (O)	*Ictiobus niger*	1/0	0/0	1/0	0.2	1/0	0/0	1/0	0.1	2/0	0/0	2/0	0.1
	Shorthead redhorse (O)	*Moxostoma macrolepidotum*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Mugilidae (mullets)	Striped mullet (X)	*Mugil cephalus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1	1/0	0/0	1/0	0.1
Ictaluridae (catfishes)	Blue catfish (C)	*Ictalurus furcatus*	8/0	0/2	8/2	1.8	19/0	1/9	20/9	2.2	27/0	1/11	28/11	2.1
	Channel catfish (A)	*Ictalurus punctatus*	4/0	1/3	5/3	1.4	1/1	4/45	5/46	3.8	5/1	5/48	10/49	3.1
	Freckled madtom (O)	*Noturus nocturnus*	1/0	0/0	1/0	0.2	2/0	0/1	2/1	0.2	3/0	0/1	3/1	0.2
	Flathead catfish (C)	*Pylodictis olivaris*	7/1	0/0	7/1	1.4	4/0	1/0	5/0	0.4	11/1	1/0	12/1	0.7
Moronidae (temperate basses)	White bass (C)	*Morone chrysops*	8/0	0/0	8/0	1.4	3/0	0/0	3/0	0.2	11/0	0/0	11/0	0.6
Centrarchidae (sunfishes)	Green sunfish (C)	*Lepomis cyanellus*	1/0	0/0	1/0	0.2	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1
	Bluegill (C)	*Lepomis macrochirus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1	1/0	0/0	1/0	0.1
	Smallmouth bass (U)	*Micropterus dolomieu*	0/0	0/0	0/0	0.0	0/1	0/0	0/1	0.1	0/1	0/0	0/1	0.1
	Black crappie (U)	*Pomoxis nigromaculatus*	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0	0/0	0/0	0/0	0.0
Sciaenidae (drums)	**Freshwater drum (A)**	***Aplodinotus grunniens***	**15/20**	**0/167**	**15/187**	**36.1**	**13/14**	**0/700**	**13/714**	**54.3**	**28/34**	**13/867**	**28/901**	**48.9**
Sub-Total			**247/123**	**4/185**	**251/308**	**100.0**	**184/215**	**9/931**	**193/1146**	**100.0**	**431/338**	**13/1116**	**444/1454**	**100.0**
Total			**559**				**1339**				**1898**			

*Approximately 900 additional (juvenile) fishes from the summer sample were reported after this document was complete. The vast majority were from the W-Dike, and were identified as Channel shiner, Silver chub, and Emerald shiner.

X - Probably occurs only as a stray from a tributory or inland stocking.
H - Records of occurrence are available, but no collections have been documented in the last ten years.
R - Considered to be rare. Some species in this category may be on the verge of extirpation.
U - Uncommon, does not usually appear in sample collections, populations are small, but the species in this category do not appear to be on the verge of extirpation.
O - Occasionally collected, not generally distributed, but local concentrations may occur.
C - Commonly taken in most sample collections; can make up a large portion of some samples.
A - Abundantly taken in all river surveys.

Overall FY12 - Physicochemical Conditions

During all sampling periods, conductivity was slightly greater at the control site than at the experimental site. Secchi visibility, dissolved oxygen levels, and water temperature were generally similar between the two sites. Velocity and pH showed no discernible pattern between the experimental and control sites (Table 13).

Table 13. Mean of water quality parameters measured at the MMR experimental (RM 3.8L-4.4L) and control (RM 18.0R-19.0R) sites from February to July 2012.

Parameter	Winter	Spring	Summer
	Experimental/Control	Experimental/Control	Experimental/Control
Specific conductivity (µS/cm)	570/594	360/374	336/402
Secchi visibility (cm)	31/31	17/23	30/27
Dissolved oxygen (mg/l)	12.8/12.6	7.5/7.3	9.2/8.5
Water temperature (°C)	6.2/6.2	26.0/25.9	31.6/30.9
Velocity (m/sec)	0.53/0.60	0.63/0.35	0.23/0.31
pH	8.2/7.1	8.0/3.5*	5.6*/7.5
Water surface elevation (feet) at Birds Point, MO gage	19.88	11.70	7.77
Water surface elevation (feet) at Cairo, IL gage	23.40	14.37	10.59

*Probable equipment malfunction

FY12 - Fishes Collected

Experimental and Control Sites Combined

Overall, 2328 individuals representing 11 families and 33 species were captured during the FY12 sampling period. Dominant fish families (>10% of total) collected included Sciaenidae (41.8%), Cyprinidae (26.8%), and Ictaluridae (11.9%) (Table 14). Dominant species (>10% of total) collected included Freshwater drum (41.8%) and Emerald shiners (14.4%). Species making up less than 1% of the total catch include Bigmouth buffalo (0.1%), Black buffalo (0.7%), Black crappie (0.04%), Blue sucker (0.3%), Bluegill (0.2%), Freckled madtom (0.2%), Green sunfish (0.04%), Longnose gar (0.4%), Quillback (0.04%), Red shiner (0.8%), River shiner (0.1%), Shoal chub (0.4%), Shorthead redhorse (0.04%), Shovelnose sturgeon (0.04%), Skipjack herring (0.3%), Smallmouth bass (0.04%), Spotted gar (0.04%), Striped mullet (0.04%), and White bass (0.9%) (Table 15).

Photo 12. Adult White bass were collected from the experimental and control sites during the FY12 sampling trips.

Species considered stray, historical, rare, or uncommon, based on the species relative abundance classification system used by Steuck et al. (2010), collected during the FY12 sampling period included Spotted gar, Quillback, Striped mullet, Smallmouth bass, and Black crappie (Table 15).

Of the total number of individuals, 799 were adults encompassing 11 families and 30 species. Dominant fish families (>10% of total) of adults collected included Cyprinidae (35.4%), Ictaluridae (19.1%), Clupeidae (13.1%), and Lepisosteidae (10.0%) (Table 14). Dominant adult species (>10% of total adults) collected included only Emerald shiner (21.7%).

Juvenile individuals numbered 1529, representing 8 families and 18 species (Tables 14 and 15)*. Dominant fish families (>10% of total) of juveniles included Sciaenidae (59.3%), and Cyprinidae (22.4%) (Table 14). Dominant juvenile species (>10% of total juveniles) collected included Freshwater drum (59.3%), Silver chub (11.6%), and Emerald shiner (10.7%)*.

No state or federally listed species were captured. However, the shovelnose sturgeon is listed as a threatened species under the "Similarity of Appearances" provisions of the Endangered Species Act. The listing took place in order to protect the federally endangered pallid sturgeon where the populations of the two species overlap in portions of the Missouri and Mississippi River basins.

Experimental Site

At the experimental site, 751 individuals, 10 families, and 27 species were collected (Tables 14 and 15). Dominant fish families (>10% of total) collected included Sciaenidae (29.7%), Cyprinidae (29.6%), Ictaluridae (15.6%), and Catostomidae (10.9%) (Table 14). Dominant species (>10% of total) collected included Freshwater drum (29.7%), and Emerald shiner (21.8%) (Table 15).

Of the total number of individuals at the experimental site, 411 were adults encompassed 10 families and 25 species (Tables 14 and 15). Dominant fish families (>10% of adults) of adults collected at the experimental site included Cyprinidae (42.6%), Ictaluridae (20.0%), and Clupeidae (10.0%) (Table 14). The single dominant species (>10% of adults) collected is the Emerald shiner (30.2%).

At the experimental site, juvenile individuals numbered 340, representing 7 families and 13 species (Tables 14 and 15). Dominant fish families (>10% of total) of juveniles included Sciaenidae (55.0%), Catostomidae (14.7%), Cyprinidae (13.8%), and Ictaluridae (10.3%) (Table 14). Dominant juvenile species (>10% of juveniles) collected at the experimental site included Freshwater drum (55.0%), River carpsucker (14.4%), and Emerald shiner (11.8%).

Species collected unique to the experimental site included Green sunfish, Quillback, Red shiner, River shiner, Shorthead redhorse, and Shovelnose sturgeon.

Control Site

At the control site, 1577 individuals representing 10 families and 27 species were collected (Tables 14 and 15). Dominant fish families (>10% of total) collected included Sciaenidae (47.6%), Cyprinidae (25.6%), and Ictaluridae (10.2%) (Table 14). Dominant species (>10% of total) collected included Freshwater drum (47.6%), Emerald shiner (10.9%), and Silver chub (10.8%) (Table 15).

Of the total number of individuals at the control site, 388 were adults encompassing 10 families and 24 species (Tables 14 and 15). Dominant fish families (>10% of adults) of adults collected at the control site included Cyprinidae (27.8%), Ictaluridae (18.3%), Clupeidae (16.5%), Lepisosteidae (12.9%), and Catostomidae (11.6%) (Table 14). Dominant adult species (>10% of adults) collected includes Threadfin shad (13.4%), Emerald shiner (12.6%), and Shortnose gar (12.4%) (Table 15).

At the control site, juvenile individuals numbered 1189, representing 8 families and 15 species (Tables 14 and 15). Dominant juvenile fish families (>10% of juveniles) included Sciaenidae (60.6%), and Cyprinidae (24.8%) (Table 14). Dominant juvenile species (>10% of juveniles) collected at the experimental site included Freshwater drum (60.6%), Silver chub (14.4%), and Emerald shiner (10.3%) (Table 15). Although over twice as many individuals were collected at the control site than the experimental site, family and species richness were very similar. The primary difference in fish assemblage is due to the large number of juveniles collected at the control site.

Species of interest, from an ecological standpoint, include a Smallmouth bass collected by electrofishing along the downstream side of control dike 18.5 (37˚02.514’ N, 89˚17.383’ W); and a Striped mullet collected by electrofishing along the upstream side of control dike 18.4 (37˚02.709’ N, 89˚17.748’ W). Species collected unique to the control site included Bigmouth buffalo, Black crappie, Bluegill, Smallmouth bass, Spotted gar, and Striped mullet (Table 15).

Photo 13. Smallmouth bass collected at the control site in July 2012.

Photo 14. Striped mullet collected at the control site in July 2012.

Table 14. Fish families collected during the FY12 sampling trips. Dominant families (> 10% catch) are indicated in bold*.

Family	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
	Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	1/0	0/0	1/0	0.1	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.04
Lepisosteidae (gars)	30/3	0/0	30/3	4.4	48/2	2/0	50/2	3.3	78/5	2/0	80/5	3.7
Clupeidae (herring)	40/6	1/0	41/6	6.3	64/66	0/0	64/66	8.2	104/72	1/0	105/72	7.6
Hiodontidae (mooneyes)	2/11	0/1	2/12	1.9	2/5	0/4	2/9	0.7	4/16	0/5	4/21	1.1
Cyprinidae (minnows)	**167/35**	**9/12**	**176/47**	**29.6**	**104/123**	**4/172**	**108/295**	**25.6**	**271/158**	**13/184**	**284/342**	**26.8**
Catostomidae (suckers)	**32/49**	**0/1**	**32/50**	**10.9**	43/5	2/1	45/6	3.2	75/54	2/2	77/56	5.7
Mugilidae (mullets)	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1	1/0	0/0	1/0	0.04
Ictaluridae (catfishes)	**54/2**	**28/33**	**82/35**	**15.6**	**62/1**	**9/89**	**71/90**	**10.2**	**116/3**	**37/122**	**153/125**	**11.9**
Moronidae (temperate basses)	11/0	0/0	11/0	1.5	10/0	0/0	10/0	0.6	21/0	0/0	21/0	0.9
Centrarchidae (sunfishes)	1/0	0/0	1/0	0.1	6/1	0/0	6/1	0.4	7/1	0/0	7/1	0.3
Sciaenidae (drums)	**34/20**	**2/167**	**36/187**	**29.7**	**30/14**	**1/706**	**31/720**	**47.6**	**64/34**	**3/873**	**67/907**	**41.8**
Subtotal	**371/126**	**40/214**	**411/340**	**100.0**	**370/217**	**18/972**	**388/1189**	**100.0**	**741/343**	**58/1186**	**799/1529**	**100.0**
Total	**751**				**1577**							

*Approximately 900 additional (juvenile) fishes from the summer sample were reported after this document was complete. The vast majority were from the W-Dike, and were identified as Channel shiner, Silver chub, and Emerald shiner.

Photo 15. Freshwater drum are usually the dominant species collected in MMR samples.

Table 15. Fish species collected during the FY12 sampling trips. Dominant species (> 10% of site and/or total catch) are indicated by bold font. Species collection by gear type is also indicated*.

Family	Common Name	Scientific Name	Experimental Adult/Juvenile				Control Adult/Juvenile				Total Adult/Juvenile			
			Electrofish	Trawl	Total	% of Experimental	Electrofish	Trawl	Total	% of Control	Electrofish	Trawl	Total	% of Total
Acipenseridae (sturgeon)	Shovelnose sturgeon (C)	*Scaphirhynchus platorynchus*	1/0	0/0	1/0	0.1	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.04
Lepisosteidae (gars)	Spotted gar (U)	*Lepisosteus oculatus*	0/0	0/0	0/0	0.0	0/1	0/0	0/1	0.1	0/1	0/0	0/1	0.04
	Longnose gar (O)	*Lepisosteus osseus*	3/3	0/0	3/3	0.8	2/1	0/0	2/1	0.2	5/4	0/0	5/4	0.4
	Shortnose gar (A)	*Lepisosteus platostomus*	27/0	0/0	27/0	3.6	46/0	2/0	48/0	3.0	73/0	2/0	75/0	3.2
Clupeidae (herring)	Skipjack herring (O)	*Alosa chrysochloris*	0/1	0/0	0/1	0.1	4/1	0/0	4/1	0.3	4/2	0/0	4/2	0.3
	Gizzard shad (A)	*Dorosoma cepedianum*	17/0	1/0	18/0	2.4	8/1	0/0	8/1	0.6	25/1	1/0	26/1	1.2
	Threadfin shad (O)	*Dorosoma petenense*	23/5	0/0	23/5	3.7	52/64	0/0	52/64	7.4	75/69	0/0	75/69	6.2
Hiodontidae (mooneyes)	Goldeye (C)	*Hiodon alosoides*	2/11	0/1	2/12	1.9	2/5	0/4	2/9	0.7	4/16	0/5	4/21	1.1
Cyprinidae (minnows)	Silver carp (A)	*Hypophthalmichthys molitrix*	16/0	0/0	16/0	2.1	27/0	0/0	27/0	1.7	43/0	0/0	43/0	1.8
	Red shiner (C)	*Cyprinella lutrensis*	19/0	0/0	19/0	2.5	0/0	0/0	0/0	0.0	19/0	0/0	19/0	0.8
	Common carp (A)	*Cyprinus carpio*	8/0	0/0	8/0	1.1	29/0	1/0	30/0	1.9	37/0	1/0	38/0	1.6
	Shoal chub (C)	*Macrhybopsis hyostoma*	0/0	6/0	6/0	0.8	0/0	2/1	2/1	0.2	0/0	8/1	8/1	0.4
	Silver chub (O)	***Macrhybopsis storeriana***	1/0	0/6	1/6	0.9	**0/0**	**0/171**	**0/171**	**10.8**	1/0	0/177	1/177	7.6
	Emerald shiner (A)	***Notropis atherinoides***	**122/34**	**2/6**	**124/40**	**21.8**	**48/123**	**1/0**	**49/123**	**10.9**	**169/157**	**3/6**	**173/163**	**14.4**
	River shiner (C)	*Notropis blennius*	0/1	1/0	1/1	0.3	0/0	0/0	0/0	0.0	0/1	1/0	1/1	0.1
Catostomidae (suckers)	River carpsucker (C)	*Carpiodes carpio*	11/48	0/1	11/49	8.0	5/5	1/1	6/6	0.8	16/53	1/2	17/55	3.1
	Quillback (U)	*Carpiodes cyprinus*	0/1	0/0	0/1	0.1	0/0	0/0	0/0	0.0	0/1	0/0	0/1	0.04
	Blue sucker (O)	*Cycleptus elongatus*	4/0	0/0	4/0	0.5	2/0	1/0	3/0	0.2	6/0	1/0	7/0	0.3
	Smallmouth buffalo (C)	*Ictiobus bubalus*	12/0	0/0	12/0	1.6	21/0	0/0	21/0	1.3	33/0	0/0	33/0	1.4
	Bigmouth buffalo (O)	*Ictiobus cyprinellus*	0/0	0/0	0/0	0.0	2/0	0/0	2/0	0.1	2/0	0/0	2/0	0.1
	Black buffalo (O)	*Ictiobus niger*	4/0	0/0	4/0	0.5	13/0	0/0	13/0	0.8	17/0	0/0	17/0	0.7
	Shorthead redhorse (O)	*Moxostoma macrolepidotum*	1/0	0/0	1/0	0.1	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.04
Mugilidae (mullets)	Striped mullet (X)	*Mugil cephalus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1	1/0	0/0	1/0	0.04
Ictaluridae (catfishes)	Blue catfish (C)	*Ictalurus furcatus*	25/1	4/30	29/31	8.0	27/0	4/43	31/43	4.7	52/1	8/73	60/74	5.8
	Channel catfish (A)	*Ictalurus punctatus*	15/0	24/3	39/3	5.6	19/1	4/45	23/46	4.4	34/1	28/48	62/49	4.8
	Freckled madtom (O)	*Noturus nocturnus*	1/0	0/0	1/0	0.1	3/0	0/1	3/1	0.3	4/0	0/1	4/1	0.2
	Flathead catfish (C)	*Pylodictis olivaris*	13/1	0/0	13/1	1.9	13/0	1/0	14/0	0.9	26/1	1/0	27/1	1.2
Moronidae (temperate basses)	White bass (C)	*Morone chrysops*	11/0	0/0	11/0	1.5	10/0	0/0	10/0	0.6	21/0	0/0	21/0	0.9
Centrarchidae (sunfishes)	Green sunfish (C)	*Lepomis cyanellus*	1/0	0/0	1/0	0.1	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.04
	Bluegill (C)	*Lepomis macrochirus*	0/0	0/0	0/0	0.0	5/0	0/0	5/0	0.3	5/0	0/0	5/0	0.2
	Smallmouth bass (U)	*Micropterus dolomieu*	0/0	0/0	0/0	0.0	0/1	0/0	0/1	0.1	0/1	0/0	0/1	0.04
	Black crappie (U)	*Pomoxis nigromaculatus*	0/0	0/0	0/0	0.0	1/0	0/0	1/0	0.1	1/0	0/0	1/0	0.0
Sciaenidae (drums)	**Freshwater drum (A)**	***Aplodinotus grunniens***	**34/20**	**2/167**	**36/187**	**29.7**	**30/14**	**1/706**	**31/720**	**47.6**	**64/34**	**3/873**	**67/907**	**41.8**
Sub-Total			**371/126**	**40/214**	**411/340**		**370/217**	**18/972**	**388/1189**		**741/343**	**58/1186**	**799/1529**	
Total			**411/340**			**100.0**	**388/1189**			**100.0**	**799/1529**			**100.0**
Grand Total			**751**				**1577**				**2328**			

*Approximately 900 additional (juvenile) fishes from the summer sample were reported after this document was complete. The vast majority were from the W-Dike, and were identified as Channel shiner, Silver chub, and Emerald shiner.

X - Probably occurs only as a stray from a tributory or inland stocking.
H - Records of occurrence are available, but no collections have been documented in the last ten years.
R - Considered to be rare. Some species in this category may be on the verge of extirpation.
U - Uncommon, does not usually appear in sample collections, populations are small, but the species in this category do not appear to be on the verge of extirpation.
O - Occasionally collected, not generally distributed, but local concentrations may occur.
C - Commonly taken in most sample collections; can make up a large portion of some samples.
A - Abundantly taken in all river surveys.

CONCLUSIONS

Based on this initial evaluation of total specimens collected, 10 families and 27 species were collected at both the experimental and control sites. The control site collections resulted in a greater numbers of individuals (primarily juveniles). Dominant species (adults + juveniles) collected at both sites included Freshwater drum and Emerald shiner, while Silver chub were also a dominant species at the control site.

Collection of adult specimens resulted in a similar number of individuals, families, and species at both the experimental and control sites. Cyprinidae, Ictaluridae, and Clupeidae were the dominant families at each site; while Lepisosteidae, and Catostomidae were dominant at the control site only. Dominant adult species at both the experimental and control sites included Emerald shiner; while Threadfin shad and Shortnose gar also a dominant adult species at the control site.

Collection of juvenile specimens resulted in a similar number of families and species at both the experimental and control sites; while the number of juvenile individuals at the control site was approximately 3.5 times that of the experimental site. Sciaenidae and Cyprinidae were dominant juvenile families at both the experimental and control sites; while Catostomidae and Ictaluridae were also dominant at the experimental site. Dominant juvenile species at both the experimental and control sites included Freshwater drum and Emerald shiner; while River carpsucker was a dominant juvenile species at the experimental site, and Silver chub was a dominant juvenile specie at the control site.

Species collected unique to the experimental site included Green sunfish, Quillback, Red shiner, River shiner, Shorthead redhorse, and Shovelnose sturgeon.

Species collected unique to the control site included Bigmouth buffalo, Black crappie, Bluegill, Smallmouth bass, Spotted gar, and Striped mullet.

Species of interest, from an ecological standpoint, include a Smallmouth bass collected along the downstream side of control dike 18.5; and a Striped mullet collected along the upstream side of control dike 18.4.

In terms of physical habitat, the innovative structures have the characteristic deep scour hole and downstream depositional area (i.e., “shallow water habitat” or “island”). Such features are either not present or as pronounced at the un-notched control sites. The notched-

dike, W-dike and MRS structures are developing a diverse flow pattern between the structural elements, thereby using the force of the river to create a more diverse habitat. Further physical monitoring of the innovative structures is warranted to determine if the scour holes and associated depositional areas persist into the future. Additional biological monitoring of these structures would promote a greater understanding of how fish assemblages are utilizing the habitat diversity created by the river training structures, as well as the structures themselves.

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