Post-bank stabilization monitoring on the Cottonwood River – a fish survey.

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by

Debra S. Baker and Donald G. Huggins

Central Plains Center for BioAssessment

Kansas Biological Survey

University of Kansas

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Background

In order to reduce sediment delivery into John Redmond Reservoir, in 2015 the Kansas Water Office (KWO) performed a stabilization project on bends of the Cottonwood River south of the town of Emporia Kansas. Because of potential harm to the federally threatened Neosho madtom (*Noturus placidus*), the USFWS requires monitoring these stabilized sites for adverse changes in madtom habitat (USFWS 2010). In 2013 the Central Plains Center for BioAssessment (CPCB) at the Kansas Biological Survey (KBS) performed the pre-stabilization monitoring on four river bends (7, 14, 23, 44) targeted for reconstruction, as well as two control sites (1, 2) which would not be stabilized (Fig. 1). Construction on three of the targeted bends (14, 23, 44) took place in 2015, thus CPCB returned in fall of 2015 to perform the post-stabilization monitoring on these three sites and the two control sites (Baker and Huggins 2016).

CPCB returned to all sites during summer 2017 to complete the first biannual post-stabilization monitoring for sites 14, 23, and 44 and to complete the initial post-stabilization monitoring of site 7. The two control sites were also re-surveyed at this time. This will fulfill the USFWS requirement that after initial post-stabilization monitoring, sites be monitored every two years for five years (USFWS 2010).

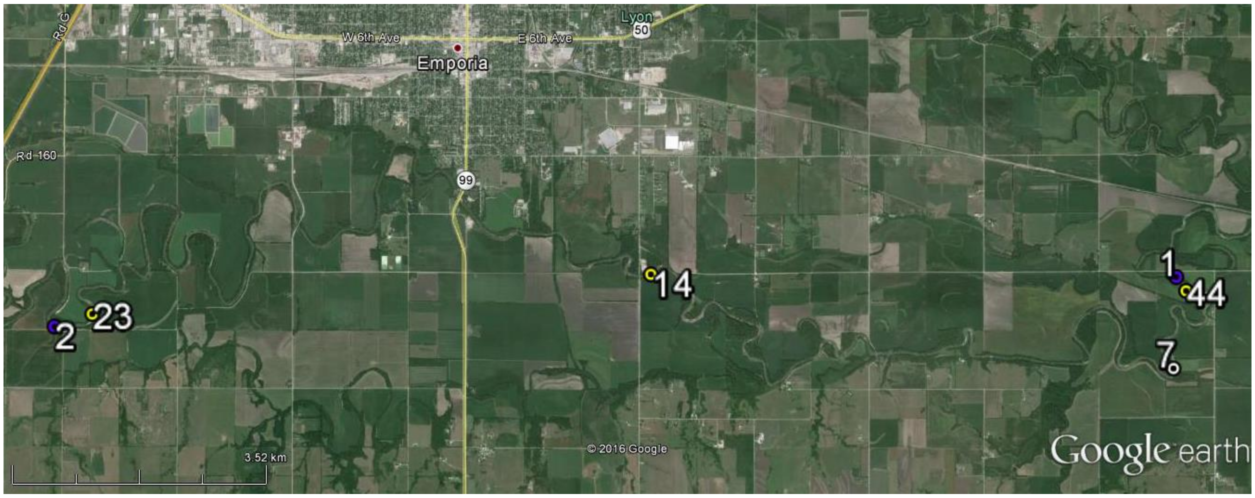

Figure 1. Sampling sites on the Cottonwood River south of Emporia Kansas. Stabilized bank sites 14, 23, and 44 are marked in yellow with stabilized site 7 in white, and control sites 1 and 2 in blue.

Water level

CPCB surveyed the sites in summer using the same protocols used in the 2013/2015 study (Baker and Huggins 2016). Timing of surveying was dependent on water levels and unfrozen water. The 2013 pre-construction surveys were completed when the USGS Station 07182260 height was approximately 2.2 ft. The 2015 post-construction surveys were completed when the station was at 1.45 ft. We were not able to perform the pre-construction survey of site 7 due to high waters levels from the time of contract completion in mid-Oct. 2016 through mid-Dec. 2016 when the construction was completed (water was never below 2.1 ft). Reconnaissance by CPCB field crew on 21 Dec. 2016 showed that while water levels had come down some, the high water froze the gravel bars making work impossible. The Cottonwood was over flood height in late March and early April 2017. Reconnaissance on 22 June 2017 when water was about 2.6 ft confirmed that it was too high to perform the survey. We sampled 12 and 13 July when levels were approximately 2.1 ft. (Fig. 2).

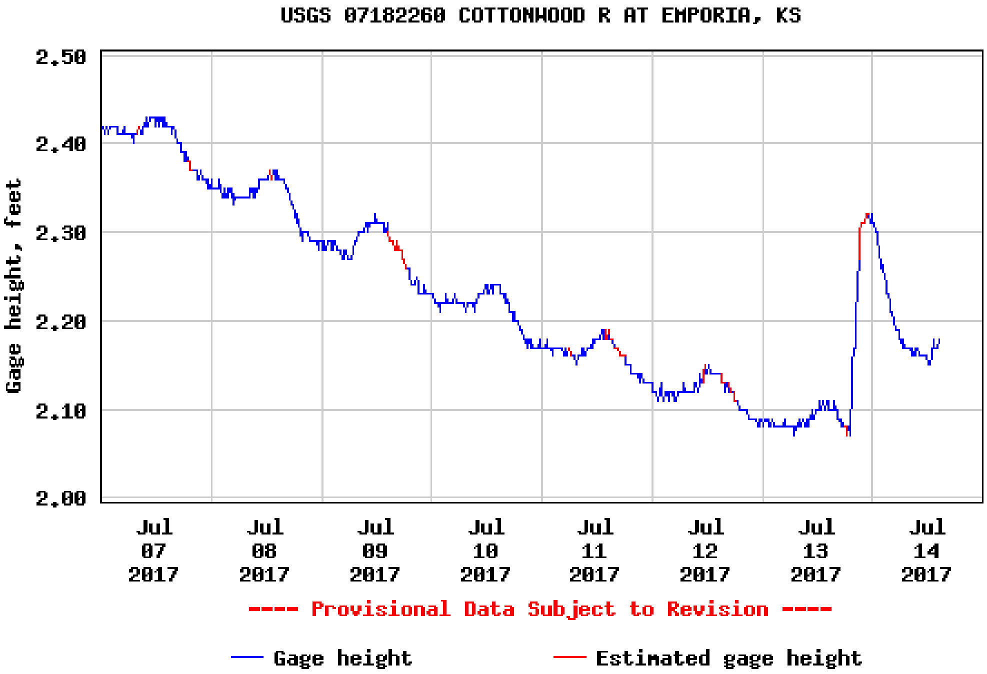

Figure 2. Gage height of USGS Station 07182260 on the Cottonwood River prior to the 12 and 13 July 2017 post-construction survey of stream banks.

Sampling Protocol

The stream reach at each monitoring site contains five transects that were previously marked by CPCB. Typically site work started with the most downstream transect and progressed upstream to reduce potential instream disturbances. The general work flow was for a 3-member field crew to travel to and confirm each site, take sediment and channel measurements, then seine the reach. Specific protocols are as follows.

Fish and instream habitat measurements

Fish sampling protocol follows sampling procedures outlined by TWI (2012) and used previously by CPCB (Baker and Huggins 2016).

1. Where possible, at each monitoring site, CPCB sampled for fish at 5 evenly spaced sample points across each transect in water depths from 0.2 foot to 4.0 feet. Marker floats were used to delineate sampling points. In areas with steeply sloping gravel bars having limited shallow water zones, CPCB crowded sample points together but did not overlap points in transect areas.
2. The field crew kick-seined about 50 square feet upstream of the sample points occurring within 0.2 to 4.0 feet of water. The seine was be 8-feet long by 6-feet deep by ½-inch mesh and made of ⅛-inch netting.

3. All benthic insectivorous fishes captured were identified and enumerated, and total lengths were recorded for all Neosho Madtom individuals.
4. Water velocity and depth at each sampling point on each transect was measured with a Swoffer flow meter.

Channel characteristic measurements included transect channel dimensions and channel bed and gravel bar composition determined following procedures from the 2012 TWI and Baker and Huggins 2016 reports. We did not survey the top-of-bank to top-of-bank cross section at each transect.

1. We used the Wolman (1954) pebble count procedure at each transect to document the representative size distribution of channel bed materials.
    a. We measured and recorded the intermediate axis of 100 randomly selected stones in water depths of 0.2 foot to 4.0 feet along the established transects.
2. We used the Rosgen (2000) bar sample procedure to document the representative gravel bar material size distribution. Multiple samples were spaced from upstream to downstream and located at the midpoint of the bar—halfway between the water's edge and bank toe.
    a. Place a bottomless bucket at 2 locations along each cross section transect on the point bar.
    b. Measure and weigh the two largest particles at the surface within the bottomless bucket.
    c. Excavate materials from the bottomless bucket to a depth twice the diameter of the largest surface particle.
    d. Wet sieve the excavated channel materials through 2 millimeters (mm), 4 mm, 8 mm, 16 mm, 31.5 mm, and 63 mm sieves.
    e. Weigh all sieved materials by size class.

Data

A complete MSAccess database is provided with this report. Below are tables and graphs summarizing the data.

Table 1. Sites, coordinates near left descending bank, data collected, and channel width at each transect. 1 indicates data collected, 0 indicates data collection not attempted (too deep, etc.).

site	transect	latitude	longitude	velocity	fish	bar sample	pebble count	channel width m
1	1	38.37497	-96.06660	1	1	0	1	29.00
1	2	38.37517	-96.06689	1	1	1	1	40.10
1	3	38.37532	-96.06703	1	1	1	1	48.20
1	4	38.37538	-96.06714	1	1	1	1	41.00
1	5	38.37551	-96.06714	1	1	0	1	36.40
2	1	38.36959	-96.24636	1	1	1	1	19.80
2	2	38.36951	-96.24623	1	1	0	1	19.40
2	3	38.36938	-96.24606	1	1	1	1	19.00
2	4	38.36940	-96.24579	1	1	0	1	23.00
2	5	38.36921	-96.24535	1	1	0	1	28.00
7	1	38.36333	-96.06735	1	1	1	1	24.40
7	2	38.36368	-96.06722	1	1	0	1	20.80
7	3	38.36389	-96.06726	1	1	1	1	13.80
7	4	38.36431	-96.06732	1	1	0	1	15.80
7	5	38.36462	-96.06746	1	1	1	1	20.40
14	1	38.37575	-96.15128	1	1	0	1	17.40
14	2	38.37580	-96.15086	1	1	0	1	16.40
14	3	38.37595	-96.15063	1	1	1	1	25.80
14	4	38.37603	-96.15039	1	1	1	1	19.40
14	5	38.37616	-96.15020	1	1	1	1	15.40
23	1	38.37043	-96.23969	1	1	0	1	16.40
23	2	38.37075	-96.23972	1	1	0	1	18.40
23	3	38.37093	-96.23979	1	1	1	1	17.40
23	4	38.37113	-96.23981	1	1	1	1	17.40
23	5	38.37140	-96.23994	1	1	1	1	18.80

Table 2. Number of fish caught at each site, with REMAP (Barbour et al. 1999) trophic designations G = generalist, H = herbivore, I = insectivore, O = omnivore, P = piscivore, V = invertivore. I* = majority of species of the genera are insectivores, I** not provided by REMAP but known insectivore. *Notropis spp*$^+$ = numerous and not completely enumerated. Site 7 was not stabilized, thus was not monitored in 2015 (ns = not sampled). Pre = sampled in 2013 before stabilization, 1 and 2 are post-stabilization sampling in 2015 and 2017, respectively.

			site	**1**			**2**			**7**			**14**			**23**			**44**		
				pre	**1**	**2**	**pre**	**1**	**2**	**pre**	**1**	**2**	**pre**	**1**	**2**	**pre**	**1**	**2**	**pre**	**1**	**2**
Family	**Taxa**	**Common name**	**t.l.**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**
Cyprinidae	*Cyprinella lutrensis*	red shiner	O			4					ns			1			1	2			1
	Campostoma anomalum	stoneroller	H	5		1					ns			1			1		1		
	Notropis spp. $^+$	shiner	I*	3^+	2	3	1^+	8		31^+	ns	3	1^+	1^+	3	6	7	1	8^+	3	8
	Phenacobius mirabilis	suckermouth minnow	I		1						ns										
	Semotilus atromaculatus	creek chub	G				1			1	ns		1								
Centrarchidae	*Lepomis*	sunfish	I*								ns								1		
	Micropterus salmoides	largemouth bass	P								ns						1				
Ictaluridae	Ictaluridae	catfish sp.	I*		1						ns										
	Ictalurus punctatus	channel catfish	P		2			2			ns						1			4	
	Noturus flavus	stonecat	I		1		1				ns		2	1			1				
	Noturus placidus	Neosho madtom	I**				5				ns			2							
	Pylodictis olivaris	flathead catfish	P					1			ns										

		site		1			2			7			14			23			44		
				pre	1	2	pre	1	2	pre	1	2	pre	1	2	pre	1	2	pre	1	2
Family	**Taxa**	**Common name**	**t.l.**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**	**13**	**15**	**17**
Percidae	*Percina caprodes fulvitaenia*	Ozark logperch	I				3				ns		3			1			2	1	
Poeciliidae	*Gambusia affinis*	western gambusia	I						4												
Sciaenidae	*Aplodinotus grunniens*	fresh water drum	V		1						ns										
Moronidae or Percichthyidae	*Morone chrysops*	white bass	P			1															
		total		8	8	9	11	11	4	32	ns	3	7	6	3	7	12	3	12	8	9

Table 3. Average depth (m) at each site, based on 2 – 5 measurements at 5 transects at each site. Site 7 was not sampled in 2015.

Site	2013	2015	2017
1	0.5	0.41	0.47
2	0.43	0.37	0.53
7	0.55	ns	0.62
14	0.37	0.29	0.47
23	0.52	0.49	0.64
44	0.53	0.32	0.64

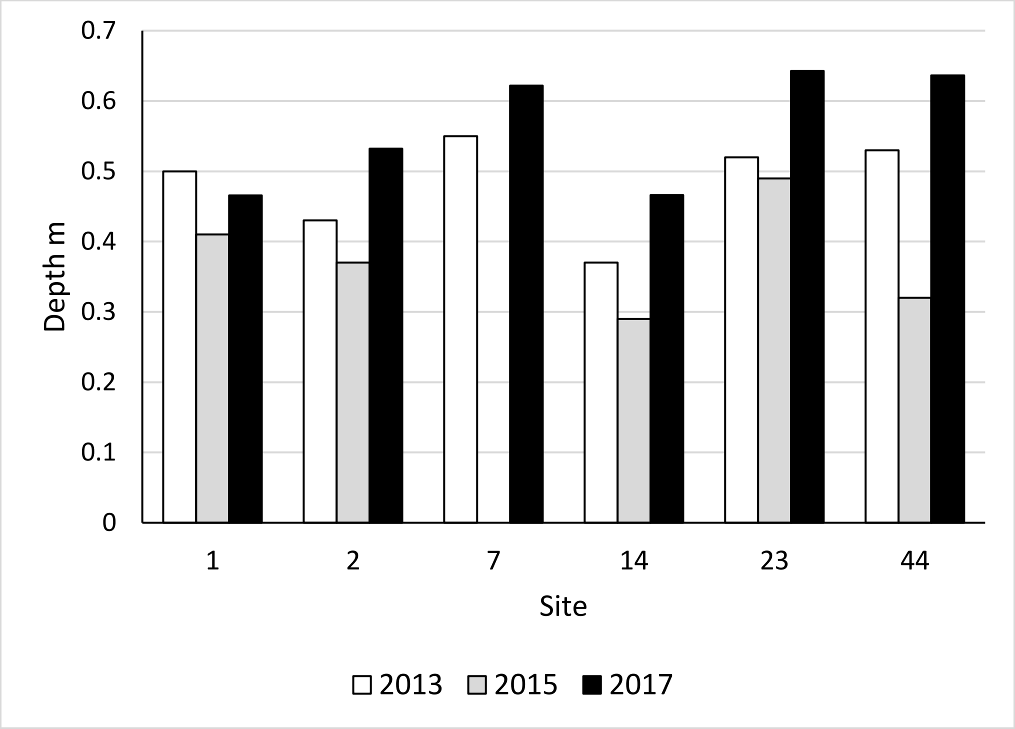

Figure 3. Average depth (m) at each site, based on 2 – 5 measurements at 5 transects at each site.

Table 4. Average velocity (m/s) at each site, based on 2 – 5 measurements at 5 transects at each site using a Swoffer flow meter. Site 7 was not sampled in 2015.

Site	2013	2015	2017
1	0.47	0.31	0.52
2	0.6	0.4	0.50
7	0.53	ns	0.61
14	0.33	0.53	0.54
23	0.69	0.31	0.52
44	0.32	0.08	0.17

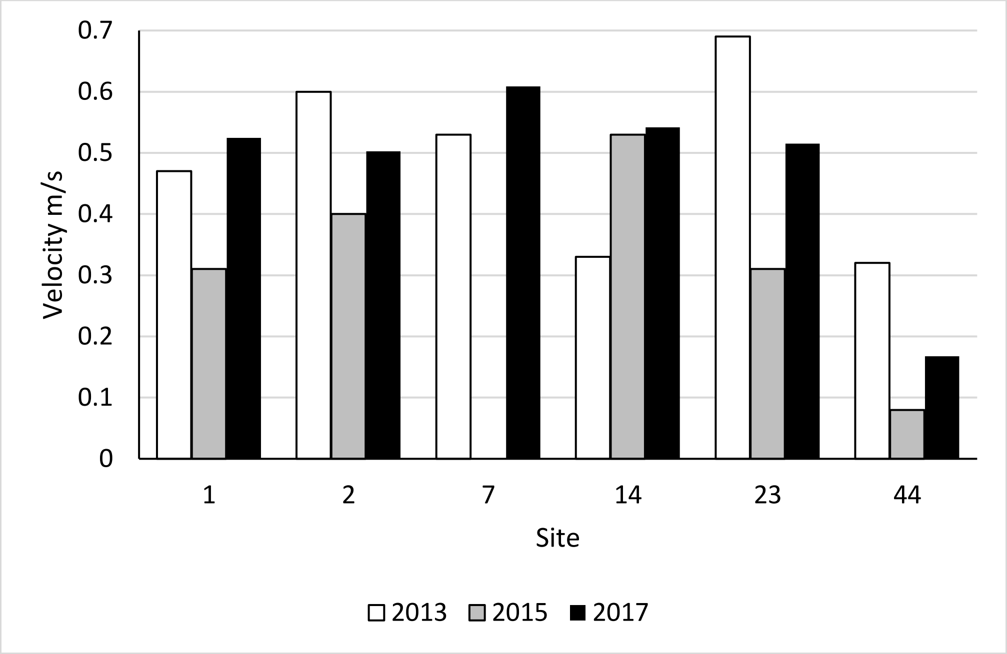

Figure 4. Average velocity (m/s) at each site, based on 2 – 5 measurements at 5 transects at each site using a Swoffer flow meter.

Table 5. Average percent substrate of stream channel at each site, based on pebble counts (Wolman 1954) at 5 transects per site (4 transects at site 44 in 2013). Site 7 was not sampled in 2015. p = pre-stabilization sampling in 2013. 1 and 2 are post-stabilization sampling in 2015 and 2017, respectively.

	site	**1**			**2**			**7**			**14**			**23**			**44**		
substrate	**mm**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**
silt	<0.062	2	17	11	0	11	5	0	ns	2	0	9	3	0	8	3	0	17	29
sand	0.062 - 2.0	9	23	30	2	12	16	1	ns	29	0	11	8	0	15	19	0	20	46
gravel	2.0 - 64	90	60	59	86	73	75	98	ns	67	93	78	84	99	74	71	95	63	25
cobble	64 - 256	0	0	0	12	5	4	1	ns	1	7	1	5	1	2	6	5	0	0
boulder	256 - 2048	0	0	0	0	0	0	0	ns	0	0	0	1	0	1	0	0	0	0
bedrock	bedrock	0	0	0	0	0	0	0	ns	0	0	0	0	0	0	0	0	0	0

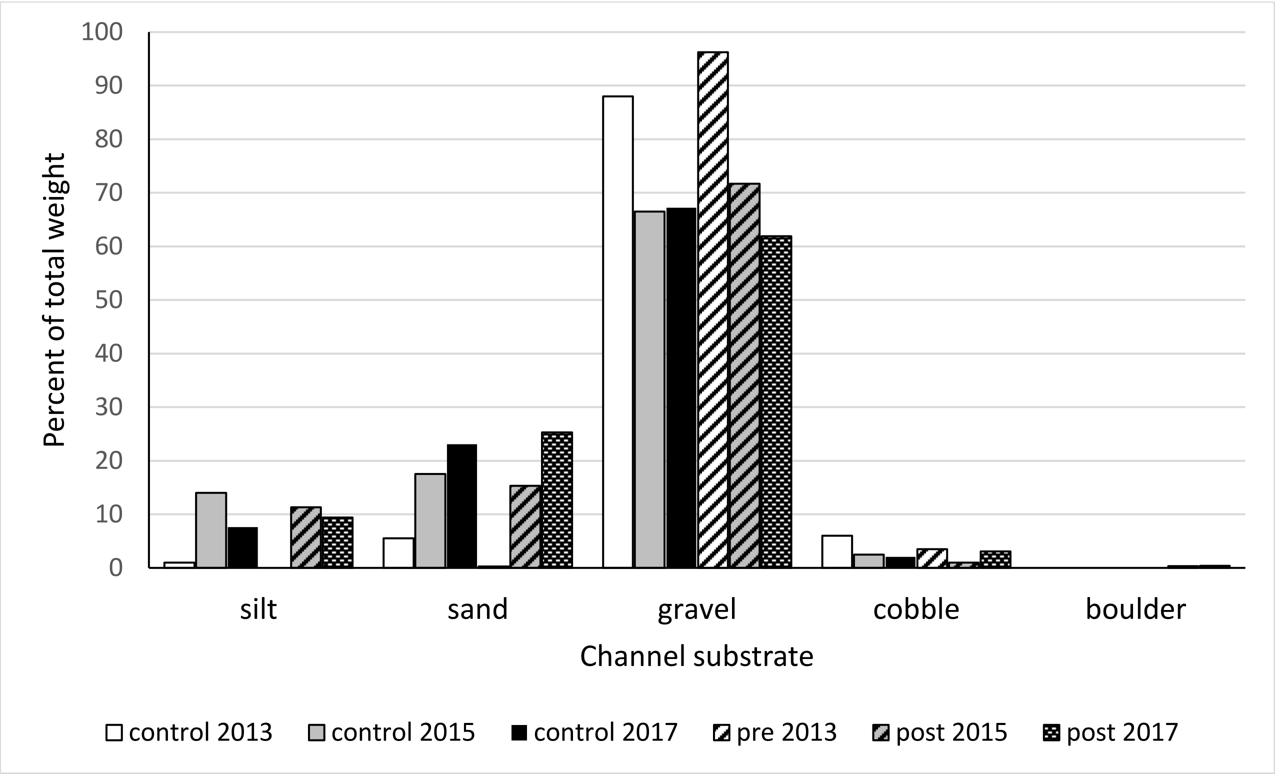

Figure 5. Average percent substrate class based on particle size of stream channel, based on pebble counts (Wolman 1954), for control sites (solid bars) and stabilized sites (patterned bars, pre-construction in 2013 and post-construction in 2015 and 2017).

Table 6. Average bar composition, by percent of total weight, of each site, based on 2 – 3 bars per site, using Rosgen (2000) bar sample procedure. Site 7 was not sampled in 2015. p = pre-construction 2013. 1 = first post-construction sampling in 2015, 2 = second in 2017.

	site	**1**			**2**			**7**			**14**			**23**			**44**		
substrate	**mm**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**	**p**	**1**	**2**
sand	< 2	35	32	35	41	23	34	38	ns	29	18	27	26	23	40	27	44	21	27
gravel	2 - 4	6	6	6	4	9	6	10	ns	6	5	8	6	6	6	7	9	10	10
gravel	4 - 8	13	13	12	12	16	10	16	ns	15	11	13	12	14	12	11	14	20	19
gravel	8 - 16	10	20	16	24	29	18	19	ns	25	17	22	16	25	27	23	14	23	22
gravel	16 - 31.5	19	23	25	18	20	24	17	ns	22	30	27	21	29	12	30	17	18	20
gravel	31.5 - 63	17	5	6	0	2	8	0	ns	2	16	4	19	4	2	2	3	8	3
cobble	> 63	0	0	0	0	0	0	0	ns	0	4	0	0	0	0	0	0	0	1

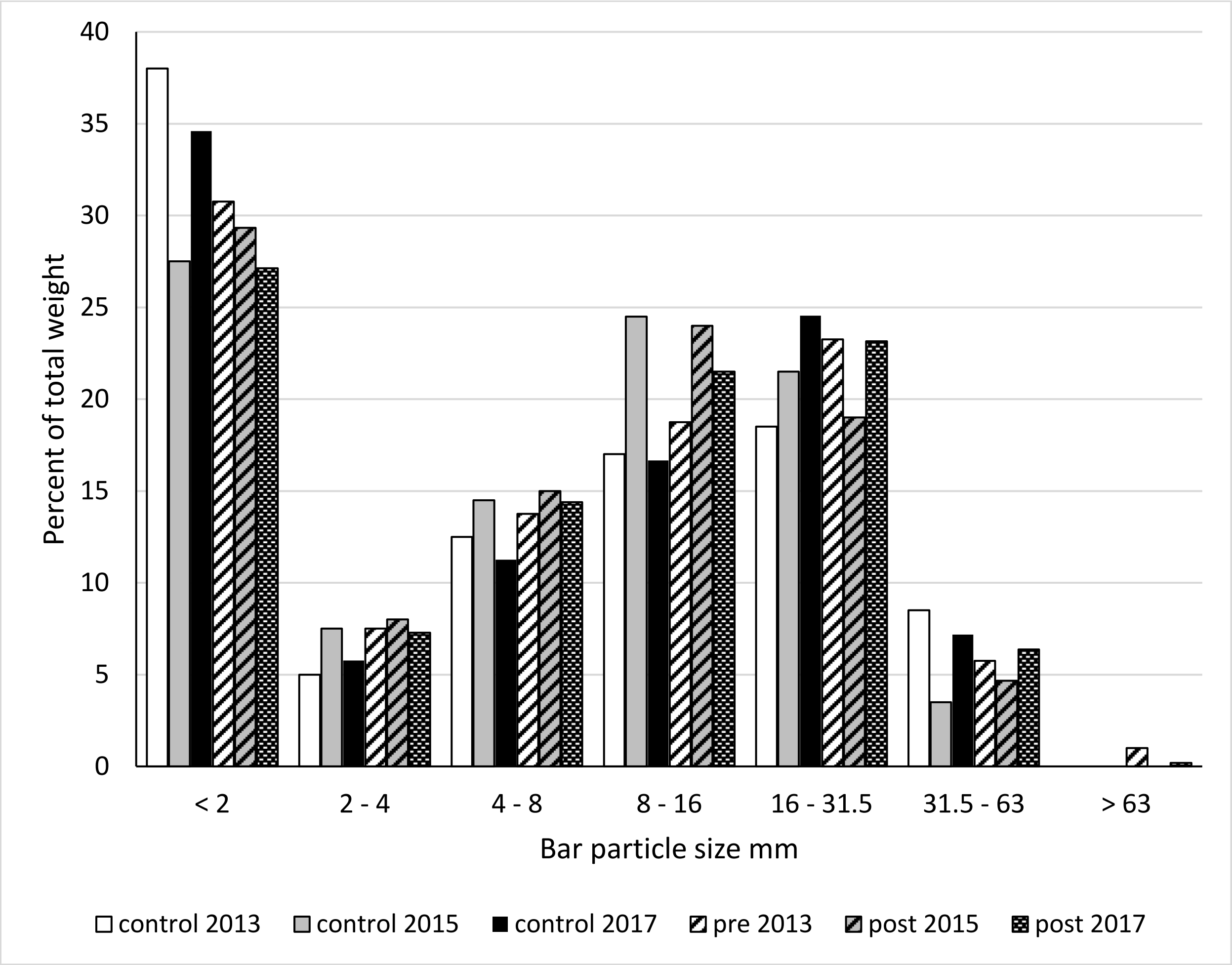

Figure 6. Average particle size composition of “gravel” bars, by percent of total weight, for control sites (solid bars) and stabilized sites (patterned bars, pre-construction in 2013 and post-construction in 2015 and 2017).

Conclusion

The 2013 measurements set a baseline of channel characteristics and fish taxa composition before the bank stabilization construction, with two sites as controls. The 2015 measurements describe conditions within six months following the stabilization, and 2017 measurements describe conditions two years later.

While graphical comparisons are useful in examining the physical differences between various gravel bar and stream characteristics, little can be said about the change in abundance of the primary species of interest in these studies (*Noturus placidus*). While some shift between the monitoring periods can be seen in overall depth, velocity, and particle sizes (Fig. 3-6), it is difficult to say with any confidence that these differences reflect long-term changes associated with bank stabilization conditions. Pre-sampling flow conditions as well as flow conditions at the time of sampling could affect velocity and depth conditions associated with transect measurements, but may not reflect overall changes in bar formation and flow over the longer term of years and decades.

Particle size distributions within the channel seem more reliable as potential indicators of long-term changes between control and stabilized study areas (Fig. 5). If no changes are expected, the stabilized sites should follow the same pattern over time in increases and decreases of percent composition of each particle size. The increases and decreases from 2013 to 2015 to 2017 of percent sand and silt in the stabilized sites do follow the same trends as that of the control sites, but changes in all categories are small. In all sites and all years, gravel comprised the highest percentage of channel substrate except for site 44 in 2017 (Table 5). Site 44 experienced a decrease in gravel throughout the sampling periods, while all other sites, even the two controls, show very little change between 2015 and 2017.

The occurrence of Neosho madtom was rare as might be expected for a Threatened and Endangered species that perhaps even historically had rather limited population sizes. In the initial pre-construction sampling period, Neosho madtoms were collected at one control site. None were found at control sites during the post-sampling period despite the fact that construction activities would not have impacted control sites. At stabilized sites, only two were collected, at site 14 in 2015.

The limited occurrence of Neosho madtoms (i.e., seven individuals) based on our collection effort does not allow for any definitive statements to be made regarding the impact of the stabilization activities on this species. Limited observations on rare, secretive, and hard to collect species, many of which are listed as Threatened and Endangered, is a common problem in many scientific studies. This problem can only be addressed through intensive spatial and temporal sampling efforts that are often costly and time consuming, making such studies rare. Limited efforts most often result in limited information that may be frustrating in interpretation but do offer some insights to the hypotheses of the study(s).

As in our previous report, we could find no indication of changing conditions that might reduce or preclude Neosho madtoms from stabilized sites. However, we must again stress that sampling efforts and results were limited and few robust statements can be made at this time regarding the long-term impact of these types of bank stabilization efforts on the Neosho madtom. Once again we recommend that at least another year (2019) of monitoring is needed to reveal if and how the stabilization has affected either channel characteristics or fish composition, specifically whether the stabilization has harmed the federally threatened Neosho madtom. We would suggest that minimal electrofishing be done in conjunction with transect seining efforts to enhance capture possibilities of bottom dwelling fish such as the Neosho madtom. The addition of electrofishing might be contested by US Fish and Wildlife as potentially harmful to madtom specimens but if electrofishing efforts are done correctly no permanent spinal or muscular damage should result, and better capture rates are possible. In addition, yearly sampling efforts should include at least a spring and fall collecting effort that would collectively better define annual conditions.

References

Baker, D.S. and D.G. Huggins. 2016. Pre- and post-bank stabilization monitoring on the Cottonwood River – a fish survey. Kansas Biological Survey Report 185. 23pp.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, 2nd ed. EPA 841-B-99-002. USEPA, Office of Water, Wash. DC.

Rosgen, D.L. 2000. River Restoration and Natural Channel Design Field Guide. Wildland Hydrology Books. Pagosa Springs, Colorado.

TWI. 2012. Upper Neosho River Basin Stream and Riparian Restoration Project: 1st Year Post-Construction Monitoring for Neosho Madtom (*Noturus placidus*) Population & Habitat. The Watershed Institute, Topeka, KS. 142pp.

USFWS. 2010. Letter Re: Upper Neosho River Basin Stream and Riparian Restoration Project. United State Dept. of the Interior, Fish and Wildlife Service. 26 Jan. 2010.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union. Volume 35. Pp. 54-74.