Fish community assessment of the Harpeth River before and after a habitat restoration project in Franklin, Tennessee

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The Harpeth River Watershed Association and its partners completed a dam removal project and habitat restoration project in Franklin, TN. An overview of the project, which was completed in 2012, was provided by Madison and Compton (2013). The Southeast Aquatic Resources Partnership (SARP) was among the many partners that provided substantial funding for the project. The Tennessee Wildlife Resources Agency (TWRA) agreed to monitor the fish community as a partner on the SARP grant proposal. This report documents TWRA's activities. The objective of the surveys was to describe the fish community in the Harpeth River in the vicinity of the dam in 2008, 2010 and 2015.

I thank the TWRA staff, TWRA volunteers, and Harpeth River Watershed Association volunteers that helped collect fish on these surveys. I also thank Charlie Saylor (formerly of Tennessee Valley Authority) for providing guidance in selecting metrics for the Index of Biotic Integrity (IBI).

Study Areas

The dam was located adjacent to Lewisburg Pike southeast of Franklin's city center. Two sites were surveyed in 2008 as a preliminary assessment. One was immediately below the dam (Below Dam). The other site was immediately upstream of the dam in the reservoir (Reservoir). After the project was awarded two additional sites were included for the 2010 and 2015 surveys (Table 1). One site was downstream of the project area at Pinkerton Park (Pinkerton) and the other site was upstream of the project area at the confluence with Fivemile Creek (Fivemile). The Fivemile site was upstream of the influence of the reservoir created by the dam. By 2015 all the habitat restoration work in the Below Dam and Reservoir sites appeared to be functioning as designed and in stable condition.

The Pinkerton, Fivemile, and Below Dam sites were established in locations that offered the best complexity of habitat types (riffle, run, and pool) for IBI surveys. In 2008 and 2010, the Reservoir site was pool habitat that was too deep for wading. In 2015 the new pool was shallower, but still too deep for wading in a majority of the site, yet the upper reaches (approximately upper one sixth of the site) had some higher velocity water (run habitat). This higher velocity water in the upper ~ 100 yards of the Reservoir site was the most obvious change of habitat at any of the sites.

In 2008 and 2010, surveys were conducted within a 14-day period, and flows were below the median of recorded levels for these dates of the year. The 2015 surveys were conducted over a period of 10 weeks due to scheduling issues associated with high flows. During this 10-week period there were 8 rain events, including two major events (peak discharge was approximately 5,000 cfs) in late June and early July. Despite higher than average flows throughout the summer, the actual survey dates selected provided effective survey conditions. The greatest difference was between 2010 and 2015 at the Reservoir site (28 cfs vs. 126 cfs). Additional discharge in 2015 added 10-12 inches of depth allowing easier access by boat. The higher flow did not obscure visibility or access to shoreline habitat in the reservoir.

Table 1. Sample dates, site locations, water temperature and conductivity, and stream discharge at 9 a.m. CDT (measured by USGS gage = Harpeth River at Franklin 03432350).

Site	Survey Date	Latitude	Longitude	Water Temp. (C)	Conductivity (uS/cm)	Flow (cfs) at Franklin Gage at 9 a.m. CDT
2008						
Below Dam	22 May 2008	35.90954	-86.85777	17	460	100
Reservoir	11 Jun 2008	35.90930	-86.85569	25	460	44
2010						
Pinkerton	16 Jun 2010	35.92099	-86.86500	27	480	23
Below Dam	15 Jun 2010	35.90954	-86.85777	28	500	21
Reservoir	9 Jun 2010	35.90930	-86.85569	29	450	28
Fivemile	23 Jun 2010	35.88615	-86.83700	28	490	14
2015						
Pinkerton	11 Aug 2015	35.92099	-86.86500	25	510	27
Below Dam	23 Jun 2015	35.90954	-86.85777	24	430	47
Reservoir	16 Jul 2015	35.90930	-86.85569	25	430	126
Fivemile	1 Sep 2015	35.88615	-86.83700	23	530	35

Methods

Pinkerton, Below Dam and Fivemile were surveyed using a seine and backpack electrofishing unit and following Index of Biotic Integrity (IBI) techniques for streams described by the Tennessee Valley Authority (1995). All riffle, run, and pool habitats were sampled until no new species were collected on three consecutive efforts, or until that habitat type had been exhausted. In riffles and runs the electrofishing unit was used to stun fish into a 20-ft seine which was opened to varied widths depending on that specific effort. Pools were seined using a 20-ft seine. A minimum of two, 150-ft shoreline shocking efforts were made at each site. Total survey effort varied by site (Table 2) as is expected using this technique. After each effort fish were counted by species and notes of any anomalies were recorded. Fish that were difficult to identify were kept as voucher specimens and later identified by ichthyologists at TWRA and TVA. If only young-of-year or age-0 fish of a given species were observed, then those were reported in the species lists, but they were not included in the species count for the IBI metrics.

Table 2. IBI survey effort at wadeable sites on the Harpeth River.

Year	Site	Number of riffle efforts	Number of run efforts	Number of pool efforts	Number of shoreline efforts	Total area of all habitats surveyed (sq ft)
2008	Below Dam	*	14	1	3	5050
2010	Pinkerton	10	7	6	2	3980
	Below Dam	6	11	12	3	5250
	Fivemile	7	10	13	2	5100
2015	Pinkerton	9	15	15	2	7575
	Below Dam	12	27	12	2	8650
	Fivemile	7	16	10	2	5100

* too deep to identify riffle habitat at this flow

IBI metrics have not been established for the Harpeth River. An IBI expert (Charlie Saylor of TVA) provided surrogate metrics based on metrics developed for the interior plateau region of Tennessee. The scoring criteria vary with watershed area. Pinkerton and Below Dam sites were close enough within the watershed to share the same criteria, whereas the Fivemile had slightly different (<1 %) scoring criteria for metrics based on percentages (Tables 3- 5). IBI scores range from 0 to 60, and the descriptions range as follows: No Fish (0-12), Very Poor (12-22), Poor (28-34), Fair (40-44), Good (48-52), Excellent (58-60).

IBI metrics for boat surveys in the Cumberland drainage have not been established nor were suitable surrogate metrics available for this type of habitat and survey method. IBI scores were not calculated for the Reservoir site. Sampling effort at the Reservoir site varied among years due to availability of gear and personnel. Each year, we shocked shoreline habitat on both sides of the river from the dam (35.90930, -86.85569) upstream approximately 2215 feet to a point adjacent to the asphalt pull-off on Lewisburg Pike (35.90624, -86.84940). At each site we attempted to collect all fish, and those collected were identified to species, counted, and released.

Due to gear issues, the electrofishing boat configuration and number of netters varied among years. In 2008 and 2015, we used a 16-ft boat with two hand-held probes delivering about 4 amps of DC current at 60/120 pulses per second. In both years two netters collected all fish at seven 10-minute sites. In 2010 we used a 14-ft boat outfitted one hand-held probe to delivering about 4 amps of DC current at 60 pulses per second. In 2008, one netter collected fish during eleven 10-minute shocking efforts.

Although similar gear and effort used at Reservoir site in 2008 and 2015, it was not appropriate to compare catch rates between years. This is because the restoration project changed the channel morphology (especially on the upper end of the site), and likely changed capture probabilities between sample years. Species and number of individuals caught each year are reported to reflect relative abundance among species within years, not to compare catch rates among years. Boat survey results do allow a comparison of species composition among years.

Results and Discussion

IBI scores for Pinkerton and Below Dam sites were both 46 (Fair/Good), in 2015, down slightly from previous scores of 48 (Good) (Tables 3-4). The IBI scores for the Fivemile site was 40 (Fair) in both years surveyed (Table 5). Compared to Pinkerton and Below Dam sites, Fivemile consistently had lower scores for number of darters and number of intolerant species. At all IBI sites three to four scores for individual metrics varied up and down by one unit between 2010 and 2015 surveys. The only common shift among sites between 2010 and 2015 scores was a one unit (2points) decrease in catch rate (number of fish/ 300 sq ft of effort).

The number of native species per site varied from 18 to 38 with the Below Dam site consistently having the most species (33-38 species) (Table 6). The number of native species collected in 2015 at Pinkerton, Below Dam, and Fivemile sites was lower by 3, 5, and 2 species, respectively compared to 2010 surveys. Prior to dam removal, we observed 18 and 19 species in the Reservoir site. In 2015 the number of native species observed at the Reservoir site increased by nine species, four of which were darter species. This may be due to the increase in riffle/run habitat in the upper section of the reservoir site.

The finescale darter which is deemed In-Need-of-Management by the Tennessee Fish and Wildlife Commission was collected at the Pinkerton site in 2015 and the Below Dam site in 2008 and 2010. The

finescale darter was not collected at the Below Dam site in 2015. Given that this fish had never been observed in great numbers at any site, with total catches per site ranging from 1 to 3 fish, not catching finescale darter at the Below Dam site is most likely due to sample variability. Other darter species that were observed in low abundance at the Below Dam site in 2008 or 2010, and not collected in 2015, were fringed darter, banded darter, orangethroat darter, and rainbow darter. Not collecting those darters and the finescale darter at the Below Dam sites might also suggest that these species have yet to recolonize the area. It was also noteworthy that blotched chub, steelcolor shiner, Tennessee shiner, telescope shiner, and highland shiner were collected for the first time during 2015 surveys.

The nile tilapia (*Oreochromis niloticus*) at the Pinkerton site in 2010 likely escaped from a pond during the 1,000-year flood of May 2010. Likewise the bigmouth buffalo was likely migrated during the flood, as they do not normally occur so far upstream in the watershed in June.

Conclusions

By 2015 the physical aspects of the habitat restoration project appeared to be very successful. The new habitat was stable and connectivity for fish was greatly improved. The lowering of the pool elevation at the Reservoir site created more habitat complexity, adding more run/riffle habitat. Observed species diversity at the Reservoir site in 2015 was higher than observed during earlier samples suggesting an improvement at this site.

The response of the fish community to habitat alterations as measured by IBI scores at Below Dam and Pinkerton was negligible. The Fivemile site was selected to serve as a control for the downstream sites in this project. Observing slightly lower scores at the Pinkerton and Below dam sites while the score at Fivemile site did not change, suggests that there was a slight change in biotic integrity at the lower sites due to some disturbance specific to these lower sites. However, such a slight change (one unit) would have to be within the margin of error for an IBI score, if this method provided a measure of variability.

It would be worthwhile to revisit the IBI sites 3 to 5 years to see if conditions change substantially. This would allow more time for fish to recolonize all the sites and it would provide a second set of post-project survey scores.

Literature Cited

Madison, H. and J. Compton. 2013. Franklin's Harpeth restoration is a national model. Tennessee Public Works Magazine 30 (7): 20-23.

Tennessee Valley Authority. 2005. Protocol for conducting an index of biotic integrity biological assessment, updated draft 2005.

Table 3. IBI metrics, scoring criteria, and scores for Pinkerton site on the Harpeth River in 2010 and 2015.

Metric Description	Scoring Criteria			2010 Observed	2010 Score	2015 Observed	2015 Score
	1	3	5				
Total number of native fish species	<18	18-35	>35	31	3	28	3
Number of darter species	<4	4-6	>6	8	5	7	5
Number of sunfish species, less *Micropterus*	<3	3-4	>4	6	5	4	3
Number of sucker species	<2	2-4	>4	3	3	2	3
Number of intolerant species	<3	3-4	>4	6	5	6	5
Percent of individuals as tolerant species	>23.3%	11.6%-23.3%	<11.6%	9.2%	5	8.4%	5
Percent of individuals as omnivores and stoneroller species	>24.9%	12.4%-24.9%	<12.4%	25.5%	1	23.8%	3
Percent of individuals as specialized insectivores	<22.0%	22.0%-44.0%	>44.0%	42.0%	3	56.0%	5
Percent of individuals as piscivores	<2.0%	2.0%-4.0%	>4.0%	2.7%	3	1.2%	1
Catch rate (average number of fish per 300 sq. ft. sampling unit)	<12	12-24	>24	31	5	21	3
Percent of individuals as hybrids	>1%	TR - 1%	0%	0.0%	5	0	5
Percent of individuals with disease, tumors, fin damage, and other anomalies	>5%	2% - 5%	<2%	0.7%	5	0	5
					48		**46**
					Good		**Fair/Good**

Table 4. IBI metrics, scoring criteria, and scores for Below Dam site on the Harpeth River in 2008, 2010, and 2015.

Metric Description	Scoring Criteria			2008 Observed	2008 Score	2010 Observed	2010 Score	2015 Observed	2015 Score
	1	3	5						
Total number of native fish species	<18	18-35	>35	33	3	38	5	33	3
Number of darter species	<4	4-6	>6	10	5	8	5	7	5
Number of sunfish species, less Micropterus	<3	3-4	>4	7	5	7	5	4	3
Number of sucker species	<2	2-4	>4	3	3	3	3	3	3
Number of intolerant species	<3	3-4	>4	4	3	6	5	7	5
Percent of individuals as tolerant species	>23.3%	11.6%-23.3%	<11.6%	7.6%	5	8.2%	5	6.9%	5
Percent of individuals as omnivores and stoneroller species	>24.9%	12.4%-24.9%	<12.4%	15.3%	3	30.8%	1	20.1%	3
Percent of individuals as specialized insectivores	<22.0%	22.0%-44.0%	>44.0%	50.9%	5	28.7%	3	45.4%	5
Percent of individuals as piscivores	<2.0%	2.0%-4.0%	>4.0%	2.3%	1	1.6%	1	1.3%	1
Catch rate (average number of fish per 300 sq. ft. sampling unit)	<12	12-24	>24	28	5	38	5	16	3
Percent of individuals as hybrids	>1%	TR - 1%	0%	0%	5	0.0%	5	0	5
Percent of individuals with disease, tumors, fin damage and other anomalies	>5%	2% - 5%	<2%	1.5%	5	0.4%	5	0	5
					48 Good		**48 Good**		**46 Fair/Good**

Table 5. IBI metrics, scoring criteria, and scores for Fivemile site on the Harpeth River 2010 and 2015.

Metric Description	Scoring Criteria			2010 Observed	2010 Score	2015 Observed	2015 Score
	1	3	5				
Total number of native fish species	<18	18-35	>35	30	3	28	3
Number of darter species	<4	4-6	>6	6	3	5	3
Number of sunfish species, less *Micropterus*	<3	3-4	>4	4	3	3	3
Number of sucker species	<2	2-4	>4	4	3	2	3
Number of intolerant species	<3	3-4	>4	4	3	3	3
Percent of individuals as tolerant species	23.6%	11.8%-23.6%	<11.8%	11.2%	5	10%	5
Percent of individuals as omnivores and stoneroller species	>25.3%	12.7%-25.3%	<12.7%	26.1%	1	34.9%	1
Percent of individuals as specialized insectivores	<22.0%	22.0%-44.0%	>44.0%	44.4%	5	33.8%	3
Percent of individuals as piscivores	<2.0%	2.0%-4.0%	>4.0%	1.1%	1	2.4%	3
Catch rate(average number of fish per 300 sq. ft. sampling unit)	<12	12-24	>24	37	5	22	3
Percent of individuals as hybrids	>1%	TR - 1%	0%	0.0%	5	0	5
Percent of individuals with disease, tumors, fin damage, and other anomalies	>5%	2% - 5%	<2%	2.4%	3	0	5
					40		**40**
					Fair		**Fair**

Table 6. Fish species and number collected at each site from Harpeth River during 2008, 2010, and 2015 surveys. There are 59 species on this list. 'yoy' indicates that only young of year were collected.

		Pinkerton		Below Dam			Reservoir			Fivemile	
Scientific Name	**Common Name**	**2010**	**2015**	**2008**	**2010**	**2015**	**2008**	**2010**	**2015**	**2010**	**2015**
Ambloplites rupestris	rock bass	5	3	3	1	2		1	4		
Ameiurus melas	black bullhead						1		2		
Ameiurus natalis	yellow bullhead				1		1	1			
Aplodinotus grunniens	freshwater drum				1	1					
Campostoma oligolepis	largescale stoneroller	79	86	17	149	75	3		13	33	66
Catostomus commersonii	white sucker			2			1			1	
Cottus carolinae	banded sculpin	2	6		6	1				1	6
Cyprinella spiloptera	spotfin shiner	18	31	1	35	17			6		6
Cyprinella whipplei	steelcolor shiner										1
Cyprinus carpio	common carp * Not Native						1				
Dorosoma cepedianum	gizzard shad	3			1	2		3	5	1	
Erimystax dissimilis	streamline chub	9	5	37	24	16				5	3
Erimystax insignis	blotched chub		32						1		41
Etheostoma blennioides	greenside darter	4	31	11	2	5			6	5	5
Etheostoma caeruleum	rainbow darter			1							
Etheostoma crossopterum	fringed darter	12		1	6					28	
Etheostoma derivativum	stone darter	3	3	10		1				9	
Etheostoma flabellare	fantail darter	3	5		2	2			1		7
Etheostoma microlepidum	finescale darter		3	1	3						
Etheostoma occidentale	westrim darter	4	13	21	10	32			14	20	18
Etheostoma rufilineatum	redline darter	60	31	8	25	21				5	9
Etheostoma spectabile	orangethroat darter			3							
Etheostoma stigmaeum	speckled darter			8		1					
Etheostoma zonale	banded darter	12	10		2						
Fundulus catenatus	northern studfish	1		1	5	5			2	2	yoy
Fundulus olivaceus	blackspotted topminnow			2	1	8	1	4		1	2
Gambusia affinis	western mosquitofish	9		5	4			3	1	1	3
Hybopsis amblops	bigeye chub		67	80	31	57			1	11	3
Hypentelium nigricans	northern hog sucker	6	23	13	14	34			28	30	38
Ictalurus punctatus	channel catfish								2		
Ictiobus cyprinellus	bigmouth buffalo							1			
Ictiobus niger	black buffalo								1		
Labidesthes sicculus	brook silverside	3	2	38	2	9	25			9	1
Lepisosteus osseus	longnose gar	1			1	1		1			
Lepomis cyanellus	green sunfish	3	8	13	12	8	15	44	15	21	11
Lepomis gulosus	warmouth			6	2		4	25			
Lepomis hybrid	sunfish hybrid							1			
Lepomis macrochirus	bluegill	41	4	20	85	20	81	101	34	38	12
Lepomis megalotis	longear sunfish	29	19	6	56	42	100	110	148	42	26
Lepomis microlophus	redear sunfish	7		3	36			2	2	14	
Luxilus chrysocephalus	striped shiner	4	4	15	1	3	6		1	47	17
Lythrurus fasciolaris	scarlet shiner		30	41	7	28	2		2	57	16
Micropterus dolomieu	smallmouth bass	1	1			yoy				2	5
Micropterus punctulatus	spotted bass		2		1	2	2	4	5	3	yoy
Micropterus salmoides	largemouth bass	2		2	5	1	20	14	13	2	4
Minytrema melanops	spotted sucker						18	2			
Moxostoma duquesnei	black redhorse	1	2		1	3	33	1	1	1	
Moxostoma erythrurum	golden redhorse	3		11	5	7	7	5	18	22	1
Notropis boops	bigeye shiner	58	72	3	65	24			5	135	58
Notropis leuciodus	Tennessee shiner										2
Notropis micropteryx	highland shiner					3					3
Notropis telescopus	telescope shiner		25			4					
Noturus exilis	slender madtom				2						
Oreochromis niloticus	nile tilapia *Not Native	1									
Percina caprodes	logperch	7		13	8	6			2	4	1
Pimephales notatus	bluntnose minnow	19	2	68	52	11	3	12	2	83	5
Pimephales promelas	fathead minnow * Not Native				2						
Pomoxis annularis	white crappie	2			3			3			
Pomoxis nigromaculatus	black crappie			6							
Semotilus atromaculatus	creek chub		1								
	Total number of individuals	**412**	**521**	**470**	**669**	**452**	**324**	**338**	**335**	**633**	**370**
	Total number of species	**32**	**28**	**33**	**39**	**33**	**19**	**19**	**28**	**30**	**28**
	Total number of naitve species	**31**	**28**	**33**	**38**	**33**	**18**	**19**	**28**	**30**	**28**