UPPER MISSISSIPPI RIVER 9-FOOT NAVIGATION CHANNEL BIOLOGICAL OPINION

WOODY STRUCTURE MONITORING

10-YEAR STATUS FINAL REPORT

Pile Dike 163.6R Construction August 2001

Pile Dike 163.6R August 2003

Pile Dike 163.6R September 2012

Kat McCain, Ph.D.

U.S. Army Corps of Engineers
Regional Planning and Environment Division North
St. Louis District
St. Louis, Missouri 63103

US Army Corps of Engineers ®
St. Louis District

March 2013

INTRODUCTION

To help insure a safe navigation channel, the U.S. Army Corps of Engineers (USACE) began removing woody snags from the Mississippi River during the 1800s. Today, this practice is all but vanished. The value of woody debris is well known, including providing cover, forage, and reproduction sites for a multitude of fish species, providing attachment sites, and habitat for aquatic macroinvertebrates, helping fuel productivity in the river by catching and retaining drifting organic material, and increasing habitat diversity by altering substrate and velocity patterns.

This project started under the Avoid and Minimize Program per request of the natural resource agencies to find ways to incorporate wood back into USACE river training structures due to the perceived lack of woody debris in the Middle Mississippi River. Simultaneously, USACE agreed to design and implement aquatic habitat restoration projects to offset defined adverse effects of continued navigation related to operation and maintenance (O&M) projects as part of the USACE consultation on the Upper Mississippi River Biological Opinion for the O&M of the 9-foot Navigation Channel (BiOp). USACE agreed to undertake small pilot habitat restoration projects that may reasonably be expected to benefit pallid sturgeon (*Scaphirhynchus albus*). The woody structure project was one of the pilot studies continued under the BiOp. Expected direct benefits included increased localized habitat diversity and potential increases in the abundance of aquatic macroinvertebrates and fishes (trophic diversity).

The woody structure pilot project placed structures at 14 locations within the Middle Mississippi River (Table 1; Figures 1-5). Locations were selected in coordination with the U.S. Fish and Wildlife Service, river industry, and state natural resource agencies. Structures were placed in 2001 and 2002. Prior to placement, most of the sites were relatively homogenous, shallow (10 to 20 feet) sandy areas with little physical diversity.

The purpose of this final monitoring report is to summarize and characterize the woody structures placed in the Mississippi River ten years post-construction and provide recommendations for future use of woody structure associated with river training structures.

Table 1. Woody structure sites in the Middle Mississippi River

Site #	River Mile	Location	Structure	Placement Date
1	187.3L	between dikes	23 log pile "dike"	December 2001
2	186.0L	between dikes	35 bundles	Dec 2001, March 2002
3	165.5R	behind L-dike	9 bundles	August 2001
4	165.1R	between dikes	6 bundles	August 2001
5	165.0R	between dikes	23 log pile "dike"	August 2001
6	163.6R	Sandbar	27 log pile "dike"	August 2001
7	148.3-147.3L	Calico chute	12 bundles	July 2001
8	119.2R	In upstream side of dike	1 log	January 2002
9	119.0R	In upstream & downstream side of dike	2 logs	January 2002
10	118.3R	In downstream side of dike	2 logs	January 2002
11	118.1R	In downstream side of dike	2 logs	January 2002
12	117.9R	In downstream side of dike	2 logs	January 2002
13	117.6R	In downstream side of dike	2 logs	January 2002
14	117.5R	In upstream side of dike	1 log	January 2002

Figure 1. Location of Sites 1 and 2 near RM 186-188L.

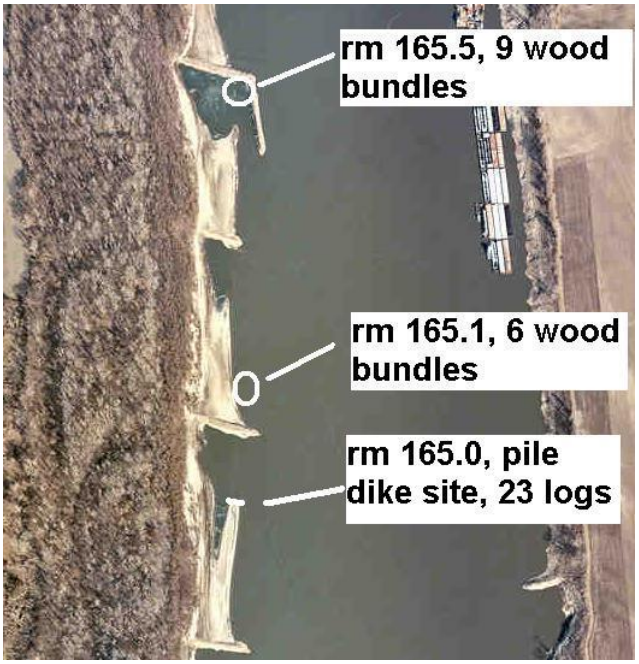

Figure 2. Location of Sites 3 to 5 near RM 165.0

Figure 3. Location of Site 6 near RM 163

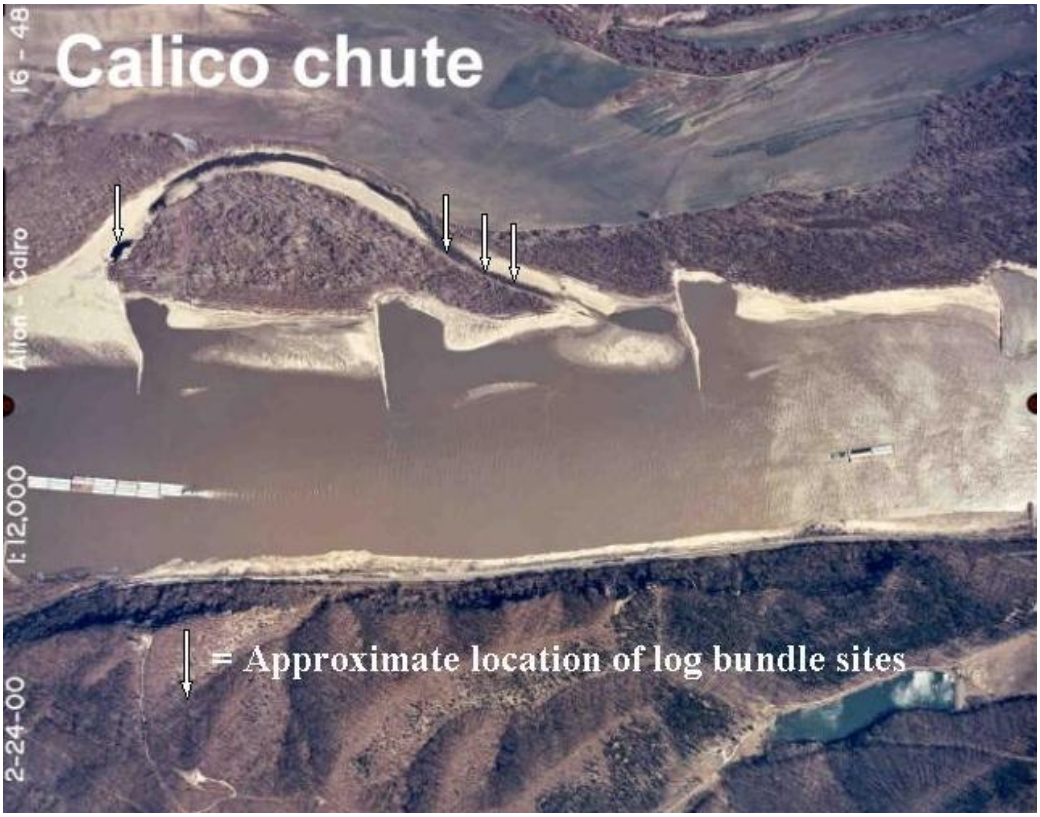

Figure 4. Location of Site 7 near RM 148 within Calico Chute

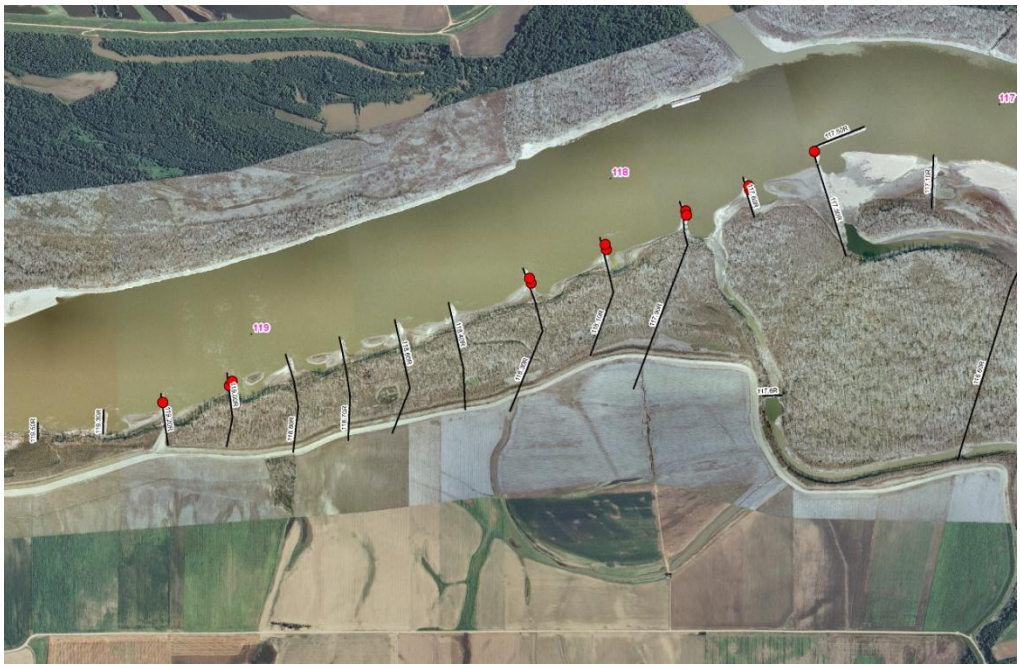

Figure 5. Location of Sites 8 to 14 where wood was incorporated into the dikes near RM 118-119

METHODS

Pre-construction Monitoring: Pre-project monitoring varied between sites, but included only multi-beam bathymetry coverage.

Post-construction Monitoring: Post-project monitoring focused on identifying the physical habitat associated with the woody structure and analysis of fish and macroinvertebrate use of that habitat. Daytime electrofishing (DC pulse rate of 120) occurred in 2003 and 2012 at sites where woody structure was inundated to assess fish use of the structures. Macroinvertebrate sampling (completed by Ecological Specialists, Inc.) occurred in 2003 at woody structure sites located at RM 186-188. This study concluded that pile dikes and wood bundles provide large woody debris for invertebrate colonization that is otherwise lacking in the MMR, and placed woody structure had a higher density and species richness, and contained a different species composition compared to the surrounding substrate[1].

RESULTS

Site 1: RM 187.3L

Site 1 consisted of a 23-log pile dike. Macroinvertebrate and substrate sampling occurred in 2003 (Photos 1 & 2). Fish sampling occurred in 2003 and 2012. In 2012, this site was dominated by Cyprinids (Table 2). A large blue sucker (760 mm), which prefers swift currents associated with natural or artificial obstructions[2], was also collected along with a channel catfish and flathead catfish (Photo 3). To date, this structure is still present, and is meeting the objectives of providing aquatic woody structure habitat and catching organic debris (Photo 4). As of 2012, this site has good flow moving through the pile dike with 17 logs still remaining vertical, but slightly slanting downstream (Photo 5).

Photo 1. Macroinvertebrates collected off of wood at Site 1 (left photo), and macroinvertebrates colonizing long (right photo). September 2003.

[1] Ecological Specialists, Inc. 2004. Final Report: Evaluation of Macroinvertebrate use of Woody Structure and Surrounding Substrate in the Open Portion of the Upper Mississippi River. Prepared for U.S. Army Corps of Engineers, St. Louis District. 71 pps.

[2] Pflieger, W.L. 1997. *The Fishes of Missouri*. Missouri Department of Conservation, Jefferson City, MO. 372 pages.

Photo 2. Substrate collected within pile dike at Site 1 (RM 187.3L). September 2003.

Table 2. Total fish count by species collected at Site 1 (RM 187.3L) using electrofishing

Family & Species Name	Year	
	2003	2012
Catostomidae		**1**
Blue Sucker		1
Clupeidae	**4**	
Gizzard Shad	4	
Cyprinidae		**133**
Bullhead Minnow		2
Channel Shiner		52
Emerald Shiner		54
Red Shiner		11
River Shiner		14
Ictaluridae	**2**	**2**
Channel Catfish	2	1
Flathead Catfish		1
Sciaenidae	**2**	
Freshwater Drum	2	
Unknown	**1**	
Unknown	1	
GRAND TOTAL	**9**	**136**

Photo 3. A large blue sucker (left) and a channel and a flathead catfish (left) collected at Site 1 in 2012.

Photo 4. Pile dike at RM 187.3L (Site 1) showing capture of organic debris in 2012

Photo 5. Pile dike at RM 187.3L (Site 1) in 2003 (left) and 2012 (right)

Site 2: RM 186.0L

Site 2 consisted of 35 woody bundles placed between the dikes. Macroinvertebrate and substrate sampling occurred in 2003. Fish sampling occurred in 2003 and 2012; however, both years number of fish collected was low due to the very swift currents moving through the area making electrofishing difficult (Table 3). In 2003, 10 of the bundles were visible or breaking the water, and field notes suggest that the wood is creating interstitial spaces and allowing organic material to be captured. In 2012, the woody bundles were barely visible (Photo 6). A large blue sucker (715 mm), which prefers swift currents, was also collected in the area in 2003, while 6 were observed but unable to be captured in 2012. In 2012, a shovelnose sturgeon was also observed within the area of the woody bundles. To date, the woody bundles are present, but the number remaining is unknown.

Table 3. Total fish count by species collected at Site 2 (RM 186.0L) using electrofishing

Family & Species Name	Year	
	2003	2012
Catostomidae	**1**	**1**
Blue Sucker	1	1
Clupeidae	**1**	
Gizzard Shad	1	
Hiodontidae		**2**
Goldeye		2
Ictaluridae		**2**
Channel Catfish		2

Photo 6. Woody bundles at RM 186.0 (Site 2) in 2003 (left) and 2012 (right)

Site 3: 165.5R

Site 3 consisted of 9 woody bundles located behind the L-Dike at RM 165.5R. Fish sampling occurred in 2003 and 2012 (Table 4). In 2012, the woody bundles were barely visible, and the number of bundles remaining is unknown (Photo 7); however they are still providing woody structure habitat in this low flow area.

Table 4. Total fish count by species collected at Site 3 (RM 165.5R) using electrofishing

Family & Species Name	Year	
	2003	2012
Catostomidae	**2**	**3**
Bigmouth Buffalo	1	2
Black Buffalo		1
River Carpsucker	1	
Centrarchidae		**2**
Bluegill		1
White Crappie		1
Cyprinidae	**14**	**5**
Common Carp	14	1
Emerald Shiner		1
River Shiner		1
Silver Carp		2
Ictaluridae	**2**	
Flathead Catfish	2	
Grand Total	**18**	**10**

Photo 7. Woody bundles at RM 165.5R (Site 3) located behind the L-Dike in 2003 (left) and 2012 (right)

Site 4: 165.1R

Site 4 consisted of 6 woody bundles placed between the dikes. Fish sampling occurred in 2003 and 2012 (Table 5). As of 2012, the woody structure was still present (Photo 6); however, the area only had water depths of 3-4 feet (St. Louis gage at -2.31ft on 20 Sept 2012).

Table 5. Total fish count by species collected at Site 4 (RM 165.1R) using electrofishing

Family & Species Name	Year	
	2003	2012
Catostomidae		**1**
Smallmouth Buffalo		1
Centrarchidae		**1**
Bluegill		1
Cyprinidae		**1**
Common Carp		1
Ictaluridae	**2**	**1**
Blue Catfish	1	
Channel Catfish	1	1
Lepisosteidae		**1**
Longnose Gar		1
Grand Total	**2**	**5**

Photo 6. Woody bundles at Site 4 (RM 165.1R) in 2003 (left) and 2012 (right)

Site 5: 165.0R

Site 5 consisted of a 23-log pile dike (Photo 7). In both 2003 (St. Louis gage at -1 ft) and 2012 (St. Louis gage at -2.31 ft), the site was not in the water therefore no fish sampling was conducted. There is evidence of macroinvertebrate colonization on the logs. Depressions have formed around the logs, however little substrate diversity was observed around the logs in 2003 (Photo 8) and vegetation was present around the logs in 2012 (Photo 9). Extensive deposition has occurred in this area.

Photo 7. Site 5 (RM 165.0R) pile dike being constructed in August 2001

Photo 8. Site 5 (RM 165.0R) showing depressions around logs (August 2003)

Photo 9. Site 5 (RM 165.0R) in September 2012

Site 6: 163.6R

Site 6 consisted of a 27-log pile dike constructed at the tip of a sand bar (Photo 10). In both 2003 (St. Louis gage at -1 ft) and 2012 (St. Louis gage at -2.31 ft), the site was not in the water therefore no fish sampling was conducted. Depressions have formed around the wood and a lot of debris has been captured in the wood (Photos 11 and 12). Based on field observations, the substrate is primarily sand on top which is covering more gravelly sand underneath (Photo 13). There is evidence of macroinvertebrate colonization on the logs (Photo 14).

Photo 10. Site 6 wood pile dike at RM 163.6R after construction (August 2001)

Photo 11. Site 6 showing organic debris captured (left) and overall appearance (right) in August 2003

Photo 12. Site 6 showing organic debris captured (left) and overall appearance (right) in Sept. 2012

Photo 13. Substrate at Site 6 in 2003 (left) and 2012 (right)

Photo 14. Evidence of macroinvertebrate colonization on logs at Site 6 (September 2012)

Site 7: Calico Chute (RM 148.3 -147.3L)

Site 7 consisted of placing 12 woody bundles within Calico Chute. In 2012, Calico Chute was disconnected and had very little water remaining in the side channel (St. Louis gage at -2.31 ft; Photos 15-16). During the field investigation 4 bundles were located (Photos 17-18) and were capturing organic debris (Photo 19). The condition of these bundles appears to be deteriorating (Photo 20). Deposition appears to be occurring around the structures as well.

Photo 15. Downstream end of Calico Chute looking upstream (St. Louis gage at -2.31 ft) in 2012.

Photo 16. Upstream end of Calico Chute looking downstream (St. Louis gage -2.31 feet) in 2012.

Photo 17. Calico Chute Bundle in 2003 (left) and in 2012 (right)

Photo 18. Woody bundles remaining in Calico Chute as of September 2012.

Photo 19. Calico Chute woody bundle capturing organic material (September 2012)

Photo 20. Calico Chute woody bundles showing condition of cables and integrity of bundles (Sept 2012)

Wood Logs Incorporated into Dikes

In 2002, 12 logs were placed within wing dikes to diversify aquatic habitat. Discussion of biological response to the wood logs was constrained since all logs present in 2012 were on the bank. Therefore, the following discussion primarily focuses on the conditions of the remaining logs as of September 2012. Overall, it appeared that the placement of the logs did not impact the integrity of the dike, even when a log was no longer present.

Site 8: RM 119.2R: One log was placed on the upstream side of dike at approximately 110ft from the wing dike tip. As of 2012, this log was still present (Photo 21), but out of the water.

Photo 21. Log in upstream side of dike 119.2R in 2002 (top photo) and in 2012 (bottom photo).

<u>Site 9: RM 119.0R</u>: Two logs placed in dike. One placed on upstream side of dike approximately 130 ft from wing dike tip. One placed on downstream side of dike approximately 45 ft from wing dike tip. The upstream log is no longer present, and the area is filled with sediment. The downstream log was still present (Photo 22), but out of the water. The downstream log did have organic material captured within the fork of the log, which when submersed would provide additional cover habitat for fish.

Photo 22. Upstream side dike 119.0R with no log present (top photo) and downstream side of dike with log present in 2002 (bottom right) and in 2012 (bottom left).

Site 10: RM 118.3R: Two logs placed on the downstream side of the dike at approximately 125 feet and 185 feet from wing dike tip. As of September 2012, these logs were no longer observed (Photo 23). However, it appears that the original placement and then loss of the logs did not degrade the integrity of the dike.

Photo 23. Two logs placed in dike 118.3R on downstream side in 2002 (top photo), but by 2012 no logs remained (bottom photo).

<u>Site 11: RM 118.1R</u>: Two logs placed in the downstream side of the dike. One at approximately 60 feet and the other at 125 feet from wing dike tip. The log at 60 feet was not present, but the log at 125 feet was present (Photo 24).

Photo 24. Location of log in Dike 118.1R in 2002 (top photo) and in 2012 (bottom photo)

<u>Site 12: RM 117.9R</u>: Two logs placed in downstream side of dike. One was located at approximately 30 feet and the other at 100 feet from wing dike tip. However, as of 2012 neither of them were present (Photo 25).

Photo 25. Logs placed in dike 117.9R in 2002 (top photo), but by 2012 they were no longer present (bottom photo)

<u>Site 13: RM 117.6R:</u> Two logs placed in downstream side of dike. These logs were placed free of charge by contractor. As of 2012, both of these logs were present (Photo 26)

Photo 26. Location of log in dike 117.6R in 2002 (top photo) and in 2012 (bottom photo)

<u>Site 14: RM 117.5R:</u> One log placed on upstream side of dike at approximately 40 feet from wing dike tip (Photo 27). Log was still present as of September 2012.

Photo 27. Location of log in dike 117.5R in 2002 (top photo) and in 2012 (bottom photo)

CONCLUSIONS

Overall, the pile dikes and woody bundles appear to be stable after 10 years and are providing fish and macroinvertebrate habitat, catching and retaining drifting organic debris, and increasing overall habitat diversity within the Middle Mississippi River.

For the wood logs incorporated into dikes, several of these logs were not recovered 10 years post-construction which suggests that these features provide a more temporary woody habitat as compared to the more lasting pile dikes and woody bundles. Compared to the pile dikes and woody bundles the wood logs are not as effective at capturing drifting organic material and providing unique habitat to fish and macroinvertebrates since fish use and macroinvertebrate colonization could not or was not observed during the 2012 field investigations due to low water. It is important to emphasize that incorporating wood logs into a dike is likely to not adversely impact the integrity of the dike even if the log has been removed by high flow events. Additionally, incorporating wood logs within a dike has the potential to provide habitat benefits for aquatic species when submersed.

RECOMMENDATIONS

1) Continued use of pile dikes and woody bundles should be pursued in the future where feasible.
2) Incorporation of downed trees within the location of a new proposed dike is recommended to provide potential added habitat diversity without adversely impacting dike integrity.
3) Adding logs with a more complex structure (as compared to unbranched trunks) into existing future dikes should be considered based on partner input and feasibility.
4) Additional innovative configurations of woody structure should be developed and monitored.
5) Based on resource agency partner needs and input, further monitoring of the woody structures discussed in this report may be pursued in the future.