Examination of Deltaic Processes of Mississippi River Outlets—Caernarvon Delta and Bohemia Spillway in Southeastern Louisiana

John A. Lopez, Theryn K. Henkel, Andreas M. Moshogianis, Andy D. Baker, Ezra C. Boyd, Eva R. Hillmann, Paul F. Connor, and David B. Baker

Lake Pontchartrain Basin Foundation, 2045 Lakeshore Dr., Ste. 339, New Orleans, Louisiana 70122

ABSTRACT

Deltaic processes of the Mississippi River Delta have been severely limited by artificial river levees, which prevent overbank flows during Spring floods. To counteract the effects of severing the connection between the river and the delta, focus has been placed on reconnecting the river to the delta by the creation of artificial outlets or diversions. The Caernarvon Freshwater Diversion and the Bohemia Spillway are two legacy diversions located on the east bank of the Mississippi River south of New Orleans.

The Caernarvon Freshwater Diversion was designed to deliver up to 8000 cfs from the Mississippi River. The sediment load in the diverted water is carried into the Caernarvon Diversion outfall area known as the Big Mar Pond. Turbidity measurements were taken from December 2009 through 2012 and used to calculate the total suspended solids (sediment load) delivered to the receiving basin. In total, approximately 264,000 yd^3 of sediment was delivered to the receiving basin. Often, the diversion is not operated when sediment spikes are present and therefore does not maximize potential sediment capture. Despite this variability in operation of the diversion, and the fact that the Caernarvon Diversion was built to minimize sediment capture, there has been enough accumulation in some areas to permanently support emergent wetland plant life on a new sub-delta. Total wetland growth of the sub-delta in Big Mar Pond from 1998 to 2011 was 600 ac. Of this total, 581 ac were new growth since 2004. This pattern is similar to that documented for other larger diverted flows, such as the Wax Lake Delta, where there is an initial delay in wetland growth as mineral soil platforms vertically accrete to a threshold on which emergent vegetation can survive.

Bohemia Spillway was created in 1926 by the removal of existing artificial river levees, thereby allowing unencumbered flow across the river's natural levee during high river stages. In 2011, the Mississippi River watershed experienced an historic flood similar to the 1927 flood which provided an ideal opportunity to investigate and study the hydrology of the Spillway. Field surveys were conducted to measure the magnitude of the overbank flow into the Spillway and a Mississippi River flow survey was conducted using Acoustic Doppler Current Profiler (ADCP) measurements. These surveys indicate that the Spillway passed 30,000 to 50,000 cfs at peak flow. Current land loss rates in the Bohemia Spillway are negligible, perhaps due to receiving inputs of freshwater, nutrients, and sediment during high river events.

It is instructive to compare the natural processes of overbank flow, sediment delivery, and deltaic land building of the two river outlets, although neither of the outlets was built for these purposes. The first three decades of discharge through the Bohemia Spillway were higher than the long-term average, and probably had greater sediment concentrations than the post-1950 sediment load, which was reduced by dams located upriver. The landscape response for the Bohemia Spillway and the Caernarvon Diversion has similarities and differences. The Bohemia Spillway has not built a delta, but it has infilled some canals, and more importantly, has prevented the pattern of indirect wetland

loss due to canals, or "interior" wetland loss due to relative sea level rise or other more regional processes. In spite of the delta development, the Caernarvon Diversion area has regionally lost wetlands since its operation began with large wetland losses occurring during Hurricane Katrina. Overall, the Bohemia Spillway wetlands are more resilient.

The history of the Bohemia Spillway does suggest sustainability may be achieved by high discharges and high sediment concentrations early in the life history of the outlet followed by years of lower discharge as the diversion becomes a tool for wetland maintenance rather than wetland building. The need for the later phase of maintenance can be also inferred from the Caernarvon Diversion pre-history. Because the Mississippi River levee was intentionally breached at Caernarvon during the 1927 flood a large sediment pulse was deposited, followed by a 65-yr hiatus in regular sediment input before the Caernarvon Diversion became operational. This hiatus undoubtedly contributed to subsequent regional land loss during Hurricane Katrina in 2005. For both Bohemia Spillway and the Caernarvon Diversion, there are clearly some benefits in reconnecting the river to the marsh.