

The Decadal Sustainability of the West Bay Sediment Diversion from Source to Sink

Introduction: To mitigate continued land loss in the Lower Mississippi Birdsfoot Delta, coastal managers have leveraged two management strategies: 1) placing dredged material on marshes to create Beneficial Use areas and 2) creating small freshwater diversions to former wetlands. In light of recent policy decisions, the CPRA Chairman stated that the organization would focus on “smaller-scale diversions higher up in the basin” (Plunk, 2025). These smaller-scale diversions have experienced short-term success; however, the longer-term effects of these diversions have yet to be quantified. One of the earliest small-scale diversions was the West Bay Sediment Diversion (2003). Previous studies quantified sediment accumulation and retention from 2004-2009 (Andrus and Bentley, 2007; Kolker et al., 2012) and the bathymetry is actively monitored by the U.S. Army Corps of Engineers (Sharp et al., 2013). These studies found that significant quantities of sediment were deposited following the passage of Hurricane Katrina (Andrus and Bentley, 2007) and that the nearshore may retain 30-70% of sediment discharged from the West Bay Diversion (Kolker et al., 2012). Nevertheless, efficient retention of sediment in the nearshore during quiescent and stormy periods does not necessarily translate to net growth within West Bay because storms can lead to sediment accretion in wetlands but erosion on the shoreface (Smith et al., 2015). Thus, we lack critical information about accumulation on the shoreface, which can be considered the foundation of the nearshore and marshes. As a result, the long-term sustainability of the West Bay Diversion, and other proposed sediment diversions, cannot be adequately assessed. We aim to address these gaps by constraining decadal sediment fluxes across the subaerial and subaqueous delta on decadal timescales because the emergence of land in a subdelta lobe lags crevasse opening by decades (Wells and Coleman, 1987).

Background: The West Bay subdelta lobe commenced growth in 1839 following the development of a natural crevasse following a storm. Since then, the subdelta lobe has grown, reached its peak subaerial area in 1940, and its subaerial area has subsequently declined, with the decline attributed to the decrease in hydraulic efficiency of channels and diminished sediment loads due to upriver damming (Wells and Coleman, 1987). To mitigate the loss of marshes, the West Bay Sediment Diversion was completed in 2003. Inventories of ^7Be from sediment cores obtained in shallow water found that the sediment diversion was effective at transporting sediment to shallow water during quiescent and storm conditions from 2004-2006, although short-term sediment accumulation rates varied spatially (Andrus and Bentley, 2007). Kolker et al. (2012) used sediment accumulation rates from ^7Be and ^{137}Cs and found that sediment accumulation rates matched flow paths. The mass balance analyses from Kolker et al. (2012) calculated significant sediment retention in the nearshore region, though the authors did not examine sediment accumulation rates on the shoreface or delta front downslope of their study area.

In 2023 and 2025, our group collected sediment cores on the subaqueous delta front offshore of West Bay and analyzed them for ^{210}Pb geochronology, which analyzes deposition over decadal timescales, and ^7Be geochronology, which constrains the accumulation of river-derived sediment

during the spring flood season (Corbett et al., 2007). Undergraduates from our lab used ^{210}Pb geochronology to calculate sediment accumulation rates of 2.6 cm/yr from an offshore sediment core (120 GC collected in 2023, Fig. 1a), which is higher than sediment accumulation observed by Kolker et al. (2012) in the nearshore region, and potentially high enough to offset subsidence. However, sediment cores collected from the delta front following the spring flood in 2025 had lower ^7Be inventories than Kolker et al. (2012) and Andrus and Bentley (2007), suggesting that 1) sediment retention in the nearshore environment has increased since 2006, resulting in less sediment bypass to the offshore environments, 2) sediment discharge through the West Bay Sediment Diversion has decreased over the past 2 decades due to sand storage in channels upstream of the diversion, as documented by Sharp et al. (2013), and/or 3) the nearshore environments of West Bay have temporary sediment retention during the spring, and sediment may be advected to deeper areas during the more energetic fall and winter. To test these scientific questions, the CSAP student could analyze CRMS data, analyze 7 previously-acquired cores for ^{210}Pb and ^{137}Cs geochronology, and collect more sediment cores in the nearshore region, closer to the study areas of Kolker et al. (2012) and Andrus and Bentley (2007; Fig. 1a).

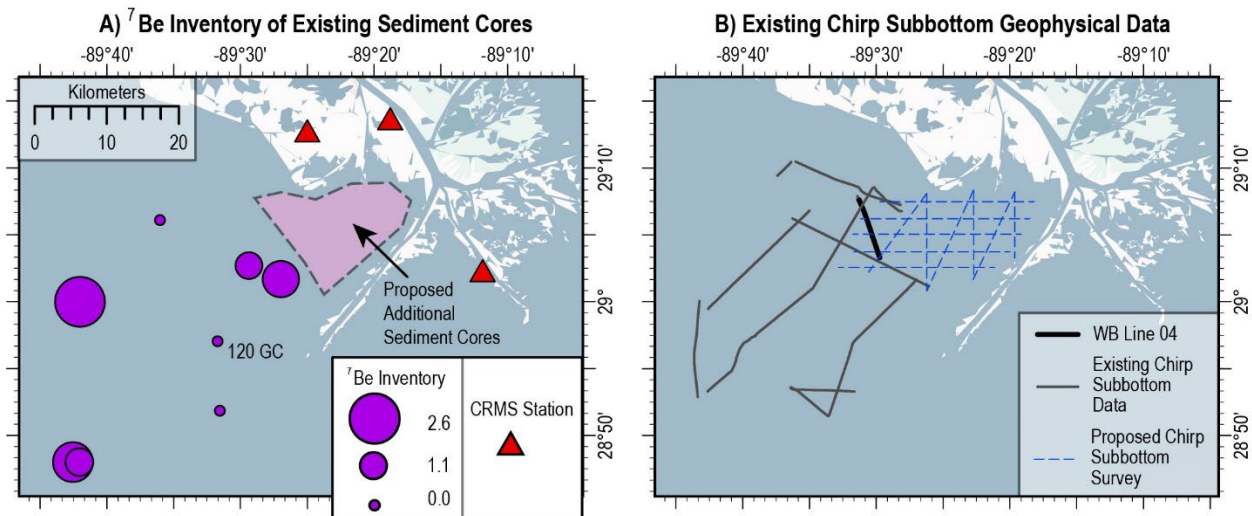


Figure 1: Existing and proposed datasets. A) The size of purple circles corresponds to ^7Be inventory of cores collected in 2023 and Spring 2025. The area proposed for future coring is shown by the pink polygon. B) Black lines symbolize existing Chirp subbottom geophysical data. A proposed Chirp subbottom survey, to be collected in Spring 2026, is shown by blue dashed lines.

Scientific Approach: The goal of our study is to quantify sediment accumulation from source (the West-Bay sediment diversion) to sink (subaqueous delta front) to better quantify sediment retention in the nearshore and bypass. To constrain sediment deposition at the sink, we will leverage pre-existing sediment cores and Chirp subbottom geophysical data that our group collected as part of the MissDelta project (Fig. 1a). The cores that we have collected and plan to collect in Spring 2026 should be sufficiently long to capture sediment accumulation over

quiescent and storm periods. Nearshore cores collected in the future may be less likely to preserve storm layers, but offshore cores may increasingly preserve layers from hurricanes such as Katrina (2005), Ida (2021), and Francine (2024). To better constrain sediment accumulation just offshore of the West Bay sediment diversion, we propose to collect a more extensive Chirp survey and a grid of sediment cores (Fig. 1b). Additionally, the proposed Chirp survey could map the distribution of distributary mouth bar sands and this information could be added to the Louisiana Sand Resources Database as a potential sand resource for future CPRA sediment management initiatives (Forrest et al., 2023). Sediment accumulation rates will be derived from ^7Be , which will constrain seasonal deposition, and ^{137}Cs and ^{210}Pb , which can capture annual to sub-decadal variability in sediment accumulation. To understand sediment dispersal at the source, we will leverage our MissDelta collaborators' hydrographic survey data that quantifies water and sediment discharge at the West Bay diversion (*sensu* Allison et al., 2023; M. Hiatt and M. Allison). Finally, we will compare sediment accumulation rates from all our sediment cores to marsh accumulation rates from CRMS station 0163. We will attempt to match quiescent and energetic intervals captured in our sediment core datasets to those from the CRMS dataset, with the possibility of constraining lags in sediment accumulation and erosion. We will integrate these analyses to calculate the retention of sediment in marshes and the nearshore region just offshore of the diversion following methods similar to Kolker et al. (2012).

Our work aims to address the following hypotheses:

- 1) Since previous studies were conducted, morphology around the West Bay Diversion has changed and hotspots of ^7Be deposition from Andrus and Bentley (2007) and Kolker et al. (2012) may have shifted.
- 2) As the nearshore area is infilled with sediment, the amount of sediment that bypasses this area may increase through time.
- 3) Storms, such as hurricanes and winter cold fronts, may contribute to seasonal deposition patterns. Sediment may be retained in the nearshore following the spring flood, but may be advected offshore due to storms.
- 4) Construction of islands offshore of Grand Pass may have improved sediment retention in the nearshore, which could be observed offshore as a decrease in sediment accumulation rates.

Relevance: If successful, our study could provide important constraints on the effectiveness of the West Bay Sediment Diversion through time, especially after the construction of islands offshore of Grand Pass. Furthermore, this source-to-sink approach will not only improve our understanding of sediment diversions but also will capture the demise of the West Bay subdelta lobe. This is important because we lack knowledge on how effectively and quickly sediment is recycled during the later stages of the delta cycle (Roberts, 1997). Finally, Chirp surveys can map the location of distributary paleochannels, which could be important sources of sand that can be dredged and used for future CPRA coastal protection projects.