Project Name: Horseshoe Bend Island

Project Location: Atchafalaya River, Louisiana, USA

Award Category: Mitigation or Adaptation to Climate Change

Team Members:
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Behind the dredge California, the river island at Horseshoe Bend on the lower Atchafalaya River, Louisiana is being self-designed by dredged sediment strategically placed upriver (lower right), allowing the river's energy to disperse the sediment. The dispersed sediment contributes to the island's growth, thus creating environmental and other benefits (Photography by Wings of Anglers, courtesy of Great Lakes Dredge and Dock).

Summary

Project Description: During the 1990s, placement of shoal material dredged from Horseshoe Bend occurred at eight wetland development sites located along the river's banklines adjacent to the channel. Capacity of these placement sites was nearly exhausted by 1999. Thus, to meet the anticipated disposal requirements for future channel maintenance, the US Army Corps of Engineers New Orleans District evaluated three placement alternatives: (1) convert the wetland development sites into upland disposal areas; (2) open water placement of dredged material via a long-distance pipeline into the open waters of Atchafalaya Bay; and (3) mounding of material at mid-river open water placement sites within a 350-acre (142 ha) area immediately adjacent to the navigation channel and upriver of a small naturally forming island. The third alternative was selected on a demonstration basis to investigate the impacts of mid-river placement on shoaling trends downriver of the site. Beginning in 2002, strategic placement of the sediment dredged from Horseshoe Bend occurred at the mid-river open water placement area. Placement of between 0.5 to 1.8 million cubic yards of sediment was conducted every 1 to 3 years which influenced and contributed to the development of an approximately 35 ha island mid-river (Figure 1). While the strategic placement of dredged sediments upriver of a naturally-occurring island was initially conducted to reduce dredging costs and promote the island's growth, additional environmental, navigation, and climate change benefits were realized using this unconventional placement practice.

Goals: The initial goal was to improve our understanding of how and why the island was formed over a 12 year period. To this end, the USACE conducted studies to better understand the hydrology of the river used to transfer the mounded material onto the island. Information regarding ecosystem classification and mapping and floral and faunal composition of the island were conducted to document environmental and other benefits being realized. This aspect of the project was the recipient of the 2015 Western Dredging Association Gold Environmental Excellence Award. Since that time, the USACE project team conducted additional analyses to identify and quantify climate change, navigation, environmental, and economic benefits, which is the focus of this nomination package.

Objectives: The project objective since 2015 was to identify and quantify the various environmental (e.g., climate change) and other benefits being realized as a result of applying best practices of beneficial use, demonstrating how dredged material can be used to nourish a naturally forming river island (Figure 1). Climate change, navigation, environmental, and economic benefits were identified and quantified to determine the multiple benefits being realized for enhancing the coastal Louisiana landscape.

Accomplishments: As the USACE increases its use of Engineering with Nature (EWN) principles and practices nationwide, capturing the full array of environmental, economic, and social benefits generated by these novel solutions becomes critical. The USACE Engineer Research and Development Center (ERDC) developed metrics to capture the benefits of strategically placing dredged material in a river system to allow nature to self-form an island downstream that is producing a wide array of benefits both for local communities and the broader ecosystem at large. These metrics can be used to justify the application of this island-building approach at other riverine sites nationwide. Demonstration of this approach on the Atchafalaya River, Louisiana, fosters its integration into USACE business practices of project design, is intended both to increase project value and to more effectively manage the nation's waterways.

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Figure 1: Horseshoe Bend Island, a 35 ha island supported by strategic dredge material placement. Note the small dredged material mound (circled) placed immediately upriver (north) of the island. Image dated October 28, 2012 (imagery provided by USACE MVN).

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B.C. Suedel and J.M. Corbino are current WEDA members. Corbino is the project manager, Suedel is the technical lead, and Berkowitz is the field lead. The USACE is the project owner and nominating entity.

Exemplifying the WODA Statement on Climate Change: The Horseshoe Bend project both exemplifies and implements the 2016 WODA Statement of Mitigation and Adaptation to Climate Change in a number of ways. The project increases navigation efficiencies by reducing the length of the Federal navigation channel, thereby decreasing the energy needed for commercial vessels utilizing the channel. The soils that formed on the island from strategically placed dredged material not only sequester carbon and create a carbon sink, they support a wide variety of native plants and animals. Substantial energy efficiencies are being realized as well, as dredging requirements in the area have been reduced (from dredging every year to dredging once every four years), thereby realizing carbon benefits due to reduced dredging activities. The realignment of the Federal navigation channel has reduced sharp

bends, thereby reducing risks associated with navigation safety. Overall, Engineering With Nature principles are being practiced by the USACE, and documenting such best practices (see below) can help advance innovation and their application nationwide. The following section provide additional detail on how the Horseshoe Bend project exemplifies and implements the 2016 WODA Statement.

Environmental Benefits: The benefits being realized by the Horseshoe Bend project communicate returns on investment (i.e., benefits) supporting the implementation of Engineering With Nature concepts. The creation and development of Horseshoe Bend Island has resulted in the realization of benefits ranging from the existence of additional wildlife habitat to waterborne navigation enhancements. To account for the benefits associated with this strategic placement of dredged material is to document the change in ecosystem services. The following services were quantified based on available data: 1) improve the environment or enhance ecosystem sustainability, 2) carbon sequestration, 3) nutrient sequestration, 4) research opportunities, and 5) navigation support and maintenance. These services capture a broad array of potential benefits associated with EWN initiatives (Bridges et al., 2015).

The improvement of the environment, specifically the new populations of flora and fauna, is a key service created on the island. The island provides approximately 6.0 ha of new emergent habitat, and 7.7 ha of aquatic bed habitat. The island supports 81 plant species and 23 animal species, including 9 species of wading birds (Figure 2). It supports both a healthy (i.e., not Chironomid-dominated) invertebrate community and a microbial community that promotes nutrient sequestration in the soil.

Figure 2. A diverse assemblage of native plant and animal life has colonized the island, including the native American lotus (*Nelumbo lutea*; upper left), various amphibians (lower left), and juvenile glossy ibis (*Plegadis falcinellus*; right) observed during nesting season.

A substantial gain in navigation support and maintenance has also been realized. The island resulted in the re-routing of the Federal navigational channel that is now 1.13 km (0.7 nautical miles) shorter, has fewer

turns, and reduced sedimentation (Figure 3). From data provided by the Port of Morgan City, it was estimated in 2015 that 4,096 vessel trips were made along the new route, including more than 1,407 trips by tug and offshore service boats. A tug traveling at 7.4 km/hour (4 knots) and consuming 300 liters (80 gal) of fuel per hour would have a transit time that is 10 minutes shorter and would consume 49 liters (13 gal) less fuel. The shorter transit time for 1,400 trips would reduce the annual fuel consumption by more than 68,000 liters (18,000 gal). The straighter route with reduced shoaling rates is also expected to result in a safer and more reliable navigation channel, although no data on accidents in the area are available since the re-routing in 2015.

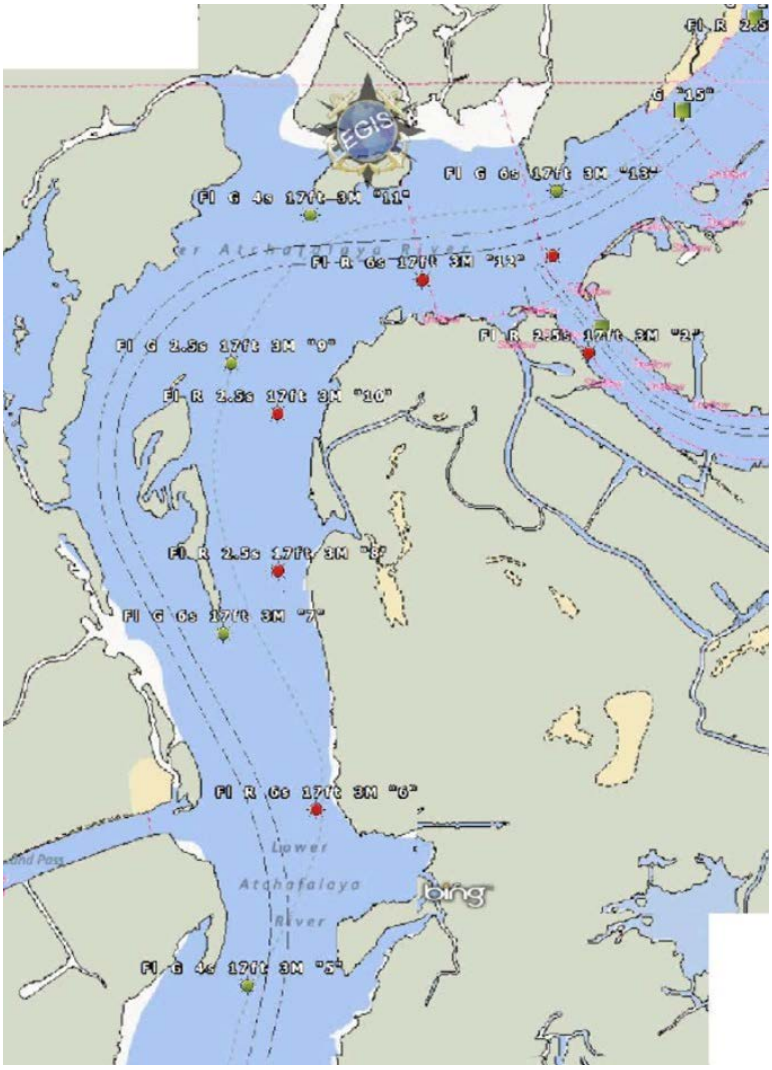

Figure 3: The realignment of the Federal navigation channel in the lower Atchafalaya River at Horseshoe Bend by the US Coast Guard in 2015 is shown by the solid red circles. The original channel is marked by the hatched parallel lines curving west of Horseshoe Bend Island.

Certain services produced through the creation of Horseshoe Bend Island, specifically carbon sequestration, nutrient sequestration, emissions reductions, research opportunities, and navigation, produce benefits that can be valued (Table 1). It was estimated that Horseshoe Bend Island will sequester an average of 5,220 kg of carbon per year assuming that this section of the river remains relatively stable

well into the future. Emissions reduction was another service that was realized as a result of the island's creation. Given the amount of fuel saved per trip and the number of trips made each year by tugs and ships, 186 million metric tons of carbon dioxide equivalent (MTCO2e; U.S. Environmental Protection Agency's conversion of a gallon of diesel fuel to MTCO2e - 0.010217) are being realized each year. The sediments reduce the load of nitrogen delivered to the northern Gulf of Mexico, with the potential to reduce the annual hypoxic zone; the contribution of the 35 ha of Horseshoe Bend Island to this reduction is 0.059%. Creation of the island has resulted in research support in the form of several projects that have been focused on the site. These projects range in value from $125K - $266K over four fiscal years with an average of $213K. The most quantifiable economic value realized as a result of the island's creation is navigational service and maintenance expressed as the reduction in dredging requirements. The three year cost of dredging prior to island creation is valued at $22.9M, and the three-year estimated cost of dredging after island creation is $9.9M. The estimated $12.9M savings translates into $4.3M per year.

Table 1. Reported marketable gains per service realized from the formation of Horseshoe Bend Island.

Service	Horseshoe Bend Amount	Conversion	Value	Units (per year)
Carbon sequestration	6.15 ha (15 ac) emergent wetlands	86 g-C/m^2 each year over 100 years	5,220 kg	Average C
Nutrient sequestration	35 ha (85 ac) wetlands	7% reduction estimated for 10,093 acres	0.059%	Nitrogen reduction in Gulf
Emission reductions	49 liters (13 gal)/trip fuel savings each year	49 liters (13 gal)/trip and 1,400 trips/year made by tugs and cargo ships	186	Metric tons of carbon dioxide equivalent (MTCO2e)
Research opportunity	4FY research support range $125K - $250K	$850K/4 yrs	$213K	2015 US$
Navigation support and maintenance	$22.9M -$10M over 3 yrs	$12.9M/3 yrs	$4.3M	2015 US$

Additional services provided by the island include sediments and plants that sequester carbon. Although wetlands sequester carbon and emit methane, recent studies indicate that temperate riverine wetlands are a net carbon sink if they exist for several decades. The nutrients sequestered in the islands sediments reduce the load delivered to the northern Gulf of Mexico, USA, where hypoxia is a significant problem. In 2013 the island was estimated to remove 1,645 kg of nitrogen (Berkowitz et al., 2016).

Innovation: Engineering With Nature (EWN) is a USACE initiative that seeks to support more sustainable practices, projects, and outcomes. The four key elements of EWN include: (1) use of science and engineering to produce operational efficiencies supporting sustainable delivery of project benefits, (2) use of natural processes to maximum benefit thereby reducing demands on limited resources, minimizing the environmental footprint of projects, and enhancing the quality of project benefits, (3) broaden and extend the base of benefits provided by projects to include substantiated economic, social, and environmental benefits, and (4) use science-based collaborative processes to organize and focus

interests, stakeholders and partners to produce more broadly acceptable projects. The Atchafalaya River island project exemplifies what can be achieved through the application of EWN concepts and practices. Sediment dredged from the adjacent Federal navigation channel during routine maintenance was strategically placed in mounds upriver of the island over 12 years (to date). The mounded material was dispersed by the river's currents to self-design the island over time.

Economic Benefits: The project uses natural processes to maximum benefits, thereby reducing demands on limited dredging resources, minimizing the environmental footprint of the project, and enhancing the quality of project benefits. Economic benefits are being realized as the enlarging island has reduced the overall cross sectional area of the river, increasing the river's flow through the navigation channel to velocities that were sufficient to reduce shoaling and maintenance dredging requirements. Costs were lower than the conventional approach because all other placement alternatives required additional equipment and land-rights to convey dredged material over long distances. Signs of human activity were also noted on the island, as the presence of shotgun shells signified that the island was being used for hunting. Intentionally aligning natural processes in the river with engineering processes via strategically mounding dredged material is realizing tangible environmental, social, and economic benefits (Table 1).

Transferability: Investigations quantifying the multiple environmental and other benefits of using dredged material to create such riverine islands will provide a more complete understanding of the formation of the island so this concept can be integrated into other dredging projects in coastal Louisiana and elsewhere, thereby providing substantial environmental, social, and economic benefits as part of ongoing USACE maintenance dredging activities. To this end, the USACE is currently applying these practices and lessons learned at other locations along the Louisiana gulf coast.

Outreach and Education:

Invited Presentations

The Technical Lead was recently invited by the PIANC Environmental Commission to present the following paper at the PIANC Navigating a Changing Climate Conference, Brussels, Belgium March 28, 2017, in a session that highlighted integrated solutions contributing to climate change mitigation or adaptation by developing and supporting solutions based on Working with Nature or integrated coastal management:

> Suedel, B.C., Burks-Copes, K., Foran, C., Berkowitz, J., and Corbino, J. Realising River Island Habitat and Navigation Benefits in the Lower Atchafalaya River, Louisiana, USA though Strategic Placement of Dredged Material.

The Technical Lead was recently invited by the PIANC Environmental Commission to co-author the following paper (related to the Horseshoe Bend project) at the 10th International SedNet Conference, Genoa, Italy. 14-17 June 2017, in a session on "Climate Change; PIANC and SedNet Think Climate!" that will highlight solutions contributing to climate change mitigation or adaptation through Engineering With Nature principles:

> Brooke, J. and Suedel, B.C. Navigating a Changing Climate: the role of sediment management in climate change mitigation and adaptation.

Peer-Review Publications

Berkowitz, J.F., Green, L., VanZomeren, C.M. and White, J.R. 2016. Evaluating soil properties and potential nitrate removal in wetlands created using an Engineering With Nature based dredged material placement technique. *Ecological Engineering*. 97:381-388.

Suedel, B., Berkowitz, J., Kim, S., Beane, N., Summers, E., Evans, D, and Corbino, J. 2015. Creating Horseshoe Bend Island, Atchafalaya River, Louisiana. *Terra Et Aqua*. 140:26-31.

Berkowitz, J.F., Beane, N.R., Evans, D.E., Suedel, B.C. and Corbino, J.M. 2015. Ecological Survey of a Dredged Material-supported Wetland in the Atchafalaya River, Louisiana: An Engineering with Nature Case Study. *Wetland Science and Practice*. 32(1):14-18.

Suedel, B.C., Fredette, T.J., and J.M. Corbino. 2014. Island Building in the Atchafalaya River, Louisiana USA: An Engineering with Nature Demonstration Project. *World Dredging*. 48(9/10):14-16.

Berkowitz, J.F., Beane, N.R., Evans, D.E., Suedel, B.C. and Corbino, J.M. 2014. "Preliminary Use of strategic placement of dredged sediment to support Horseshoe Island in the Atchafalaya River, Louisiana: A preliminary ecological survey." EWN Technical Notes Collection ERDC TN-EWN-14-4. Vicksburg, MS: US Army, Engineer Research and Development Center. *http://el.erdc.usace.army.mil/*.