# Ecological Survey of a Dredged Material-supported Wetland in the Atchafalaya River, Louisiana: An Engineering with Nature Case Study

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The geographical extent of wetlands continues to decrease at national and regional scales, including major wetland losses across southern Louisiana (Barras et al. 2003; USACE 2004). Wetland distribution and functional losses in coastal Louisiana have been linked to a lack of sediment inputs among other causes (Day et al. 2007). These losses have been accompanied by a decrease in wetland functions.

The U.S. Army Corps of Engineers (USACE) conducts dredging activities to maintain navigation channels in the lower Atchafalaya River (Figure 1). These dredging activities remove sediment from navigation channels, which is then available for the creation and/or expansion of wetlands (Boustany 2010). During the 1990s, placement of shoal material dredged from the Horseshoe Bend section of the river occurred at eight wetland development sites located along the river's banklines (Berkowitz et al. 2014). Capacity of these placement sites was nearly exhausted by 1999. Thus, to meet the anticipated disposal requirements for future channel maintenance, in 2002 USACE began mounding dredged material in an open water placement site upriver of a small naturally forming shoal. Open channel displacement reduces transport costs associated with moving sediment to traditional disposal areas or open ocean disposal. The strategic placement of sediments upstream of the natural shoal area created a 35-ha wetland island (Figure 2). As a result, this project adheres to USACE Engineering With Nature (EWN) principles by utilizing natural processes in support of navigation and environmental goals (Bridges et al., 2014; Gerhardt-Smith and Banks 2014; http://el.erdc.usace.army.mil/ewn/). In 2014, USACE constructed a new navigation channel route on the east side of the island. The new route is anticipated to increase flow velocities in the navigation channel, encouraging the channel to "self maintain" and reducing dredging maintenance requirements. Any required future activities will adhere to EWN principles by mounding dredged material upriver of the island or in the former navigation channel.

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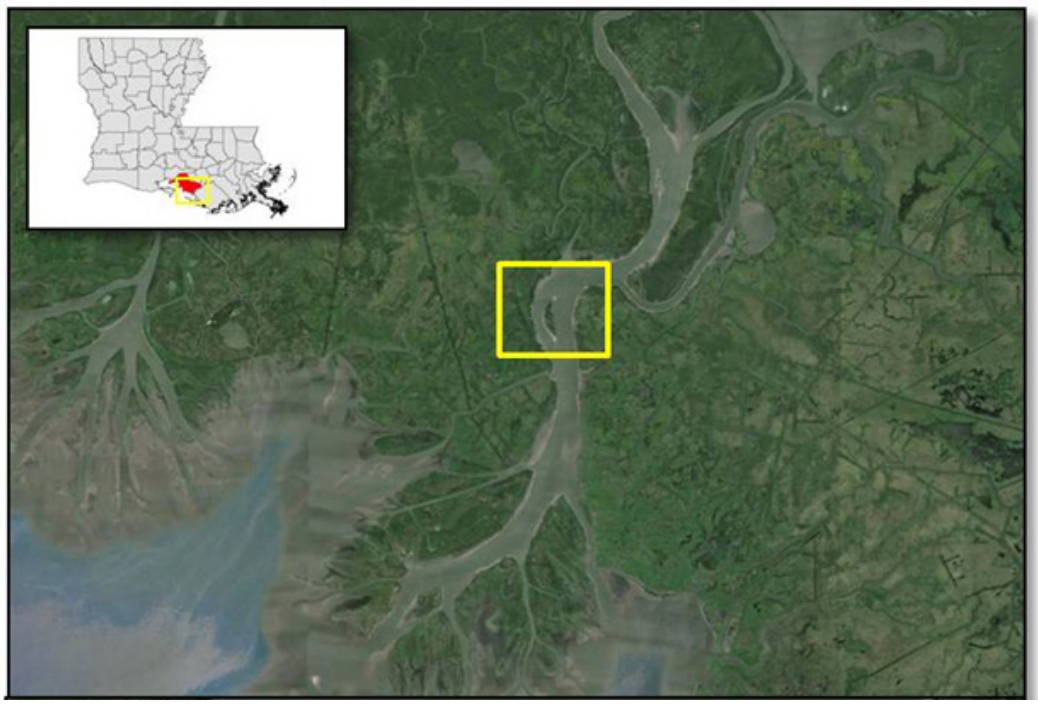

Figure 1: Study location (rectangle) within the lower Atchafalaya River, St. Mary Parish, LA.

This article presents results from an initial ecological survey of the 12-year old created wetland island to quantify the ecological functions and benefits of strategic open water placement of dredged material. Ongoing and future research initiatives are also discussed.

## Methods

Aerial image interpretation, ground truthing, and recorded GPS reference points were evaluated to determine ecological community boundaries and island area (Figure 3). Wetlands were classified according to Cowardin et al. (1979). Data collection occurred during August 2013 .Vegetation sampling included quantification of dominant species

within each distinct vegetative community. Seven sample plots were located within forested,shrub-scrub, and emergent habitats on the island and seven sample plots were evaluated in aquatic bed environments with submerged and emergent vegetation. Within each wooded area, dominant overstory species, tree stem density within 0.04 ha plots, and shrub-sapling stem densities within two nested 0.004 ha sub-plots were recorded. Herbaceous ground cover were also estimated within four representative 1 m2 sub-plots. In the aquatic beds, ocular estimation of percent vegetation cover (USACE 2010) included all rooted, free-floating, and visibly submerged aquatic species within four representative 1 m2 sub-plots . Incidental observations of all faunal species encountered on the island were recorded. Species were identified visually, by their calls, or by the presence of indirect signs (e.g., scat and tracks). Soils were examined at each sample location within each wetland community (USACE 2010; USDA-NRCS 2011). Soil descriptions included soil horizon depth, matrix color, redoximorphic features, and textural analysis within 50 cm (20 in) of the surface.

## Results

### Wetland Vegetation

Wetland classification identified four distinct types on the island: palustrine forested wetland, palustrine scrub-shrub wetland, persistent emergent wetland, and aquatic bed features. Forested, shrub-scrub, and emergent wetlands occupied approximately 12 ha (34%) of the island (Figure 3). These habitats were dominated by black willow (*Salix nigra*), eastern baccharis (*Baccharis halimifolia*) and common elderberry (*Sambucus nigra* ssp. *canadensis*) . Other prominent species included annual marsh elder (*Iva annua*) and red mulberry (*Morus rubra*). The average diameter of woody stems was 12.5 cm dbh, ranging from 5-20 cm dbh. Total tree density per hectare ranged from 1,500 to 17,325 woody stems. Ground cover ranged from 4-48% (average 20%). Average tree height was 6 m, with a maximum height of 10 m. Higher elevations exhibited dogfennel (*Eupatorium capillifolium*) and stiff dogwood (*Cornus foemina*). Less commonly observed were buttonbush (*Cephalanthus occidentalis*), climbing hempvine (*Mikania scandens*), whorled marsh pennywort (*Hydrocotyle verticillata*), smallspike false nettle (*Boehmeria cylindrica*), flatsedge (*Cyperus* sp.), goldenrod (*Solidago* sp.), hairypod cowpea (*Vigna luteola*), broadleaf cattail (*Typha latifo-*

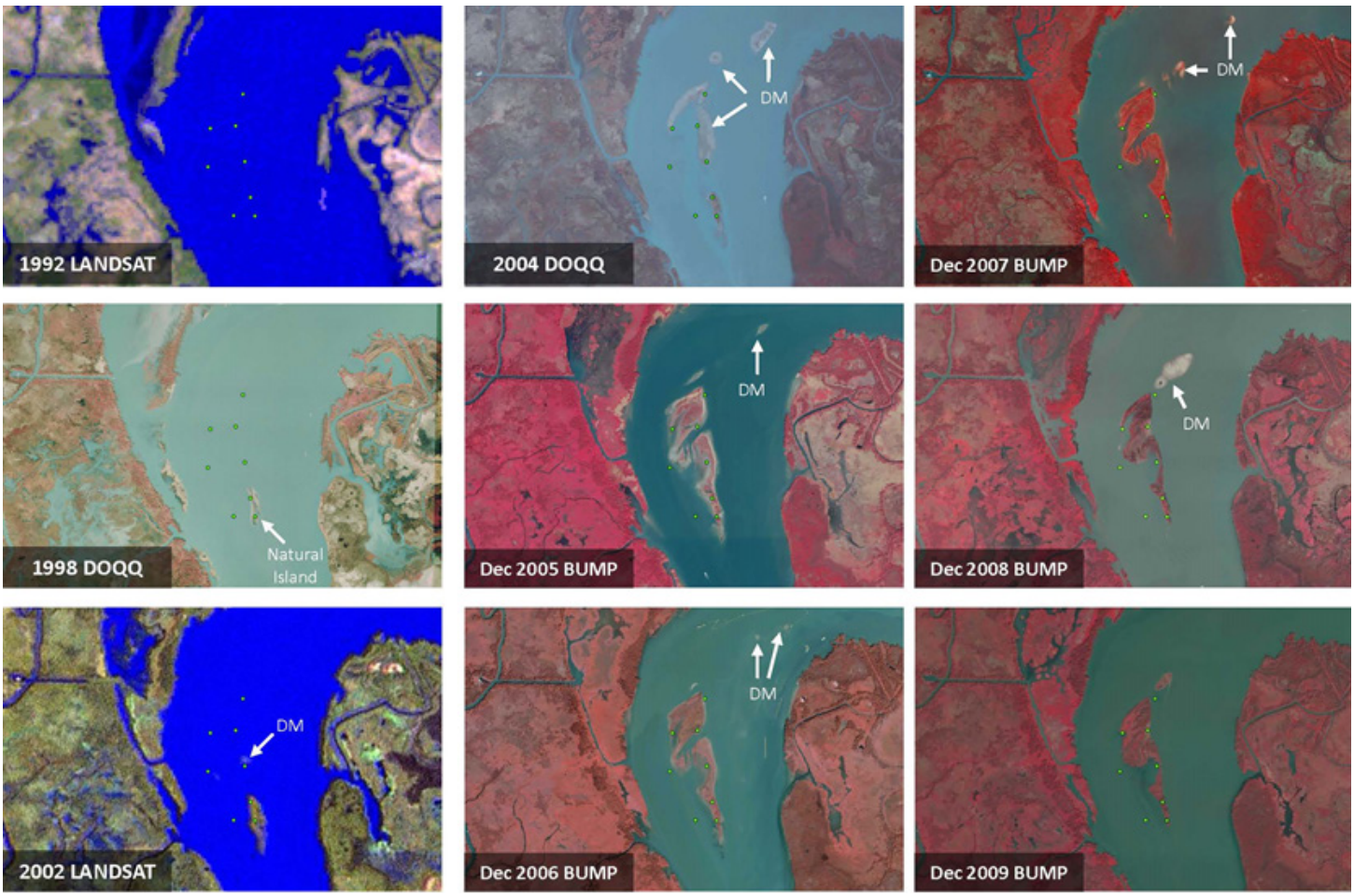


Figure 2: Imagery displaying island location prior to dredged material (DM) placement and subsequent formation (1992 and 1998 images), establishment, and growth since placement began in 2002 (USACE New Orleans District). The island is located at latitude 29°31'37.50"N, longitude 91°16'25.80"W.

*lia*), invasive Chinese tallowtree (*Triadica sebifera*), rose mallow (*Hibiscus lasiocarpos*), and broadleaf arrowhead (*Sagittaria latifolia*). Dominant herbaceous layer species in emergent wetlands varied from densely aggregated clumps of vegetation >1 m in height (e.g., coco yam (*Colocasia esculenta*)) to extensive ground cover by invasive torpedo grass *(Panicum repens*), smartweed (*Polygonum* spp.), or invasive alligatorweed (*Alternanthera philoxeroides*). Aquatic beds occupied approximately 23.1 ha (66%) of the island. Three species predominated common water hyacinth (*Eichhornia crassipes*), alligatorweed, and water sprangles (*Salvinia minima*; Table 1). A comprehensive list of all plants observed on the island was developed (USDA 2013; Berkowitz et al 2014).

**Table 1. Vegetation species and abundance in aquatic bed wetlands.**

| Species | Common name | Average cover (%) |
|---|---|---|
| *Eichhornia crassipes* | Common water hyacinth | 37.5 |
| *Alternanthera philoxeroides* | Alligatorweed | 34.8 |
| *Salvinia minima* | Water spangles | 31.7 |
| *Lemna minor* | Common duckweed | 12.5 |
| *Ludwigia* sp. | Primrose-willow | 10.0 |
| *Hydrilla verticillata* | Waterthyme | 6.5 |
| Open water | Open water | 5.2 |
| *Nelumbo lutea* | American lotus | 4.6 |
| *Leersia oryzoides* | Rice cutgrass | 1.0 |
| *Colocasia esculenta* | Coco yam | 0.2 |

Figure 3. Recording data on species composition of the marsh.

**Wildlife**

Twenty-three faunal species representing 12 families were observed on the island during the site visit (Table 2). Wading birds were the primary vertebrates observed. An active rookery containing juvenile white ibis, great egret, and other species was found on the northwest corner of the island (Figure 4). Several species of seabirds were seen in the immediate vicinity of the island. Four reptile species and the exoskeleton of one White River crawfish were found. No mammals were observed on the island but several burrows and "runs" (likely made by small mammals) were noted. One bald eagle was seen taking flight from the island, but no other species of concern were encountered.

**Soils**

Soils textures ranged from loamy sands to very fine sands. Surface soil layers contained thin dark, organic rich horizons (10YR 3/1 or 10YR 3/2) underlain by depleted materials (e.g., 10YR 5/2) in subsurface horizons. Soils exhibited redoximorphic concentrations and met one or more field indicators of hydric soils (USDA-NRCS 2011). Observed hydric soil indicators included: F3 – depleted matrix, S6 – sandy redox, and A5 – stratified layers. Additionally, soils displayed the presence of buried surface horizons, signatures of recent sediment inputs, and indicators of active soil forming processes associated with overbank flooding and material deposition. Detailed soil descriptions are provided in Berkowitz et al. (2014).

## Discussion and Conclusion

Horseshoe Bend Island exhibited four distinct wetland types including forested, scrub-shrub, emergent, and aquatic bed assemblages within a relatively small area (35 ha). The created island contained a diverse array of species characteristic of the larger Atchafalaya River wetland ecosystem, with 81 plant and 23 animal species observed. Faulkner and Poach (1996) conducted a vegetation survey within created and natural wetlands in the Atchafalaya Basin, identifying a total of 53 plant

species. The higher number of species found at Horseshoe Bend Island suggests that its species richness and diversity is comparable to other wetlands in the region. Additionally, Faulkner and Poach (1996) and Craft et al. (1999) report that created wetlands require 5 to 10 years prior to approaching the vegetation characteristics observed within natural wetland ecosystems. Thus, the 12-year successional development of Horseshoe Bend Island appears comparable with similar-aged natural wetland ecosystems in the region. The occurrence of an active bird rookery on the island is particularly noteworthy since no other active rookeries were observed within the portion of the Atchafalaya River examined.

The soils of the created island displayed common properties characteristic of riverine wetlands exposed to periodic inundation, overbank flooding, and sediment deposition (Vepraskas 2001; Noe and Hupp 2009). The abundance of depleted materials interspersed with higher chroma sandy minerals from recent flooding events with buried soil horizons and wavy/turbulent boundary transitions demonstrated the frequency of deposition events as observed through the presence of stratified layers (USDA-NRCS 2011). Further, the development of dark, organic-rich surface horizons indicated a decrease in microbial decomposition rates resulting fromanaerobic conditions (Vepraskas and Sprecher 1997). The profusion of redoximorphic features indicates that chemical reduction regularly occurs within island soils, promoting wetland biogeochemical functions including carbon sequestration, nutrient cycling, removal and sequestration of elements and compounds, and denitrification (Reddy and DeLaune 2008; Smith and Klimas 2002).

Initial surveys of vegetation, fauna, and soils suggest that the 12-year old Horseshoe Bend Island provides ecological functions and services at levels comparable to similar-aged ecosystems within the region. Ongoing studies will 1) quantify the density and community composition of avian nesting sites, 2) examine infaunal communities in aquatic bed wetland sediments, 3) measure nutrient cycling functions of island soils, and 4) compare vegetative characteristics to other wetland islands in the region. An additional benefit being realized is that as the island enlarges it reduces the overall cross-sectional area of the river, potentially increasing flow through the navigation channel to velocities sufficient for reduced shoaling and dredging requirements. As a result, a model is being developed to examine channel morphology and hydrodynamics. ■


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Figure 4. Juvenile snowy egret observed in rookery on Horseshoe Bend Island.

**Table 2. Faunal species observed during the ecological survey of a dredge material supported island.**

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| *Alligator mississippiensis* | American alligator | *Fulica americana* | American coot |
| *Anas discors* | Blue-winged teal | *Gelochelidon nilotica* | Gull-billed tern |
| *Anolis carolinensis* | Carolina anole | *Haliaeetus leucocephalus* | Bald eagle |
| *Archilochus colubris* | Ruby-throated hummingbird | *Hydroprogne caspia* | Caspian tern |
| *Ardea alba* | Great egret | *Leucophaeus pipixcan* | Franklin's gull |
| *Ardea herodias* | Great blue heron | *Libellula needhami* | Needham's skimmer |
| *Corvus brachyrhynchos* | American crow | *Nerodia rhombifer* | Diamond-backed watersnake |
| *Egretta caerulea* | Little blue heron | *Ajaja ajaja* | Roseate spoonbill |
| *Egretta rufescens* | Reddish egret | *Procambarus acutus* | White River crawfish |
| *Egretta thula* | Snowy egret | *Quiscalus quiscula* | Common grackle |
| *Egretta tricolor* | Tricolored heron | *Sterna forsteri* | Forster's tern |
| *Erythemis simplicicollis* | Eastern pondhawk | *Sterna hirundo* | Common tern |
| *Eudocimus albus* | White ibis | *Thamnophis proximus orarius* | Gulf Coast ribbon snake |

## References


Barras, J., S. Beville, D. Britsch, S. Hartley, S. Hawes, J. Johnston, P. Kemp, Q. Kinler, A. Martucci, J. Porthouse, D. Reed, K. Roy, S. Sapkota, and J. Suhayda. 2003. *Historical and Projected Coastal Louisiana Land Changes: 1978–2050*. U.S. Geological Survey, USGS Open File Report 03–334, Washington, D.C.

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

Bridges, T.S., Lillycrop, J., Wilson, J.R., Fredette, T.J., Suedel, B.C., Banks, C.J. and Russo, E.J. 2014. Engineering With Nature Promotes Triple-Win Outcomes. *Terra et Aqua*. 135:17-23.

Boustany, R. G. 2010. Estimating the benefits of freshwater introduction into coastal wetland ecosystems in Louisiana: Nutrient and sediment analyses. *Ecological Restoration 28*(2), 160-174.

Corwardin, L. M., Carter, V., Golet, F. C., and E. T. Laroe. 1979, Reprinted 1992. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Fish and Wildlife Service, FWS/OBS-79/31, 103 pp. Washington, D.C.

Craft, C., Reader, J., Sacco, J. N., and Broome, S. W. 1999. Twenty-five years of ecosystem development of constructed Spartina alterniflora (Loisel) marshes. *Ecological Applications 9*(4), 1405-1419.

Day, J. W., Jr., D. F. Boesch, E. J. Clairain, G. P. Kemp, S. B. Laska, W. J. Mitsch, K. Orth, H. Mashriqui, D. J. Reed, L. Shabman, C. Simenstad, B. J. Streever, R. R. Twilley, C. C. Watson, J. T. Wells, and D. F. Whigham. 2007. Restoration of the Mississippi Delta: lessons from hurricanes Katrina and Rita. *Science* 315:1679–1684.

Faulkner, S. P., and Poach, M. E. 1996. *Functional Comparison of Created and Natural Wetlands in the Atchafalaya Delta, Louisiana*. Technical Report WRP-RE-16. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Gerhardt-Smith, J.M., and C.J. Banks. 2014. *USACE Regional Sediment Management and Engineering With Nature 2013 Workshop Summary*. EWN Technical Notes Series. ERDC TN-EWN-14-3, Vicksburg, MS: US Army Engineer Research and Development Center. *www.engineeringwithnature.org or http://el.erdc.usace.army.mil/ewn*

Noe, G. B., and Hupp, C. R. (2009). Retention of riverine sediment and nutrient loads by coastal plain floodplains. *Ecosystems 12*(5), 728-746.

Reddy, K.R., and DeLaune, R.D. 2008. *Biogeochemistry of Wetlands: Science and Applications*. CRC Press. Boca Raton, FL.

Smith, R. D., and Klimas, C. V. 2002. *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Selected Regional Wetland Subclasses, Yazoo Basin, Lower Mississippi River Alluvial Valley*. ERDC/EL TR-02-4 US Army Engineer Research and Development Center, Vicksburg, MS.

U.S. Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS). 2011. *Field Indicators of Hydric Soils in the United States, Version 7.0*. ed. L. M. Vasilas, G. W. Hurt, and C. V. Noble. Washington, DC: USDA NRCS in cooperation with the National Technical Committee for Hydric Soils.

U.S. Department of Agriculture (USDA). 2013. The PLANTS Database (http://plants.usda.gov, 25 October 2013). National Plant Data Team, Greensboro, NC 27401-4901 USA.

U.S. Army Corps of Engineers (USACE). 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0)*, ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-10-20. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Army Corps of Engineers. 2004. Louisiana coastal area (LCA), Louisiana: ecosystem restoration study. U.S. Army Corps of Engineers, New Orleans, Louisiana.

Vepraskas, M. J. 2001. Morphological features of seasonally reduced soils. In: *Wetland Soils: Genesis, Hydrology, Landscapes, and Classification*. Lewis Publishers. Boca Raton, FL., 163-182.

Vepraskas, M. J. and S. W. Sprecher. 1997. Overview of aquic conditions and hydric soils. In: M.J. Vepraskas and S.W. Sprecher (Eds.). *Aquic Conditions and Hydric Soils*. Soil Science Society of America. Madison, WI.