Wetlands Research Bulletin

Characterization and Restoration of Wetlands Research Program

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Dredged Material Marshes: Summary of Three Research Projects

by Bill Streever

The Corps and others have intentionally used dredged material to create or restore salt marshes since 1969. Despite three decades of experience, debate continues regarding the "success" of these efforts. During planning, design, or construction phases of dredged material marsh projects, interagency discussions about the potential for success or issues related to site design frequently become bogged down because of personal opinions and impressions based on limited experience with dredged material marshes. All too often, information from the scientific literature is ignored. Over the past year, three studies that will add useful information to these discussions have been completed under the Characterization and Restoration of Wetlands Research Program at the U.S. Army Engineer Research and Development Center, Waterways Experiment Station. All three studies were designed to provide information that could be used by Corps employees involved with planning, design, or construction of dredged material marshes. A special issue of *Wetlands Ecology and Management*, targeting dredged material wetland research, will publish all three of these studies some time this year.

Success of Dredged Material Wetlands—Literature Review

A literature review identified several definitions of success, identified problems associated with commonly used approaches to data analyses comparing natural and dredged material marshes, and extracted data from several papers to conduct meta-analyses comparing natural and dredged material marshes. Important findings from this review include the following:

- Use of the term "success" varies widely. Some authors appear to consider establishment of marsh vegetation as the key criterion for success, while others seem to believe that successful

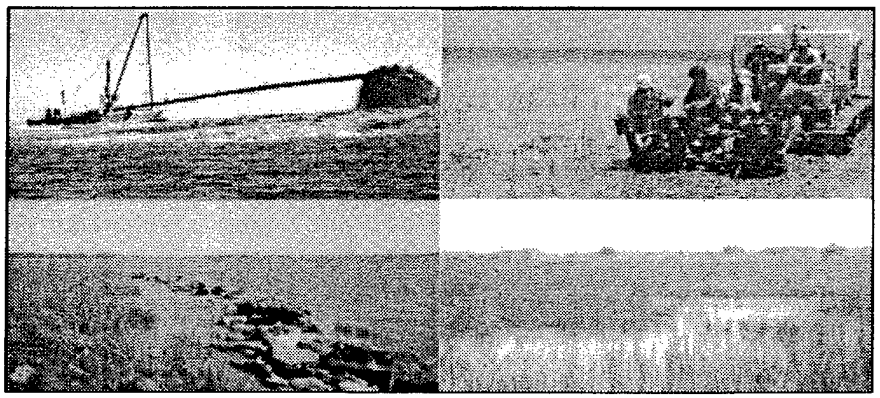

Figure 1. Marshes can be constructed by placing dredged material on shallow bay bottoms to build up elevations to an intertidal level, usually by pumping hydraulically dredged material to the marsh construction site (upper left). At sites exposed to high wind or wave energy, protective structures, such as riprap breakwaters (lower left), are built to protect dredged material. Vegetation can be actively planted (upper right), although some projects rely on natural recruitment. Within two to three growing seasons, dredged material marshes can appear similar to natural marshes (lower right). Photographs from U.S. Army Engineer Research and Development Center, Waterways Experiment Station.

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dredged material marshes should be similar to natural marshes in all respects. Authors seldom assess success on the basis of goals and objectives stated in planning or design documents.

- Authors frequently use statistical analyses to draw conclusions about all dredged material marshes on the basis of comparisons between a single natural marsh and a single dredged material marsh. Even where authors sample more than a single pair of marshes, they frequently apply and interpret statistical tests in a manner that is, at best, questionable. Readers should recognize that statistical comparison of natural and dredged material marshes is not straightforward, and that statistical analyses may be misused or misinterpreted.
- Reliable techniques of vegetation establishment on dredged material are now widely available, and there can be little doubt that dredged material marshes are usually successful if "success" is defined by establishment of vegetation cover. However, if similarity between natural and dredged material marshes constitutes success, the door is open to considerable controversy. Meta-analyses suggest that mean belowground biomass of smooth cordgrass, organic carbon in sediments, polychaete densities, and crustacean densities in natural and dredged material marshes may differ. No evidence of differences was found for smooth cordgrass stem densities, oligochaete densities, or fish densities. Data were insufficient for comparison of bird densities and geomorphological characteristics. There was virtually no evidence suggesting that dredged material marshes become more similar to natural marshes over time (as has been suggested by many authors on the basis of individual studies), in part because high interannual variability masks trends over time.
- Although many authors have reported differences between natural and dredged material marshes, few have offered concrete information about the root cause of the differences, and fewer still have offered suggestions for improved design or construction methods that could eliminate differences. In short, this review shows that dredged material marshes, on average, provide many, but not all, of the functions attributed to natural marshes.

Figure 2. Collecting core sample for belowground biomass measurements in a Texas marsh

Long-term Development of Invertebrate Communities—Winyah Bay, SC

A common criticism of all created wetlands, including dredged material marshes, is that there is little information about long-term development of sites. The Winyah Bay site in South Carolina has three dredged material marshes, one created in 1977, one created in 1981, and one created in 1988. Previous studies have looked at invertebrate communities of all three sites, and a long-term development study undertaken by WES in 1999 followed up on these previous studies. Key findings include the following:

- There is little evidence supporting the belief that invertebrate community structure develops over time. Instead, invertebrate communities on these dredged material sites appeared to be stable in terms of their relative abundance of different species, even though absolute densities varied among sites and sampling dates.
- Despite commonly held beliefs that link vegetation community structure with invertebrate community structure, there was no real difference between invertebrate communities on dredged material sites with distinctly different vegetation communities. Invertebrate community structure

appears to be driven by recruitment opportunities rather than vegetation community structure. These results help close the gap in our understanding of long-term invertebrate community development on dredged material marshes.

Comparison of Geomorphic Features—Texas

After construction, marshes are usually judged on the basis of ecological criteria. However, during planning, design, and construction, only geomorphology can be controlled. If appropriate geomorphology is created, appropriate plant and animal communities should develop. A comparison of geomorphic variables between natural and dredged material marshes in Texas, using site visits and Geographic Information System (GIS) analysis of aerial photographs, was undertaken in early 1999. Key findings include the following:

- Marsh edge is known to provide important habitat for fish and invertebrates, but according to some sources dredged material marshes have less marsh edge than natural marshes. Actual measurements from this study suggest that there is no evidence of differences between dredged material marsh and natural marsh mean edge:area ratios in Texas. However, edges of isolated ponds and depressions, rather than edges of tidally connected creeks and shoreline, account for significantly more edge habitat in natural marshes than in dredged material marshes. If a dredged material marsh project is intended to imitate natural marshes, methods should be developed to create small isolated ponds and depressions and to improve the similarity between natural and dredged material marsh geomorphology.
- Frequently, riprap breakwaters or other structures are built to protect dredged material wetlands from wind and wave energy. Exposure index values computed from data on mean wind speed and fetch distances from 16 directions ranged from less than 1 to 95. There was no significant difference between mean dredged material marsh and natural marsh exposure index values. This suggests that dredged material marshes are, on average, being constructed in areas with exposures similar to those of natural marshes. Furthermore, protective structures at the two dredged material marshes with the highest exposure index values had degraded over time, but neither site was suffering from serious erosion problems. This suggests that substantial, permanent structural protection may not be as important as is popularly believed. Considerable savings could be realized if less substantial protective structures are used in site construction,

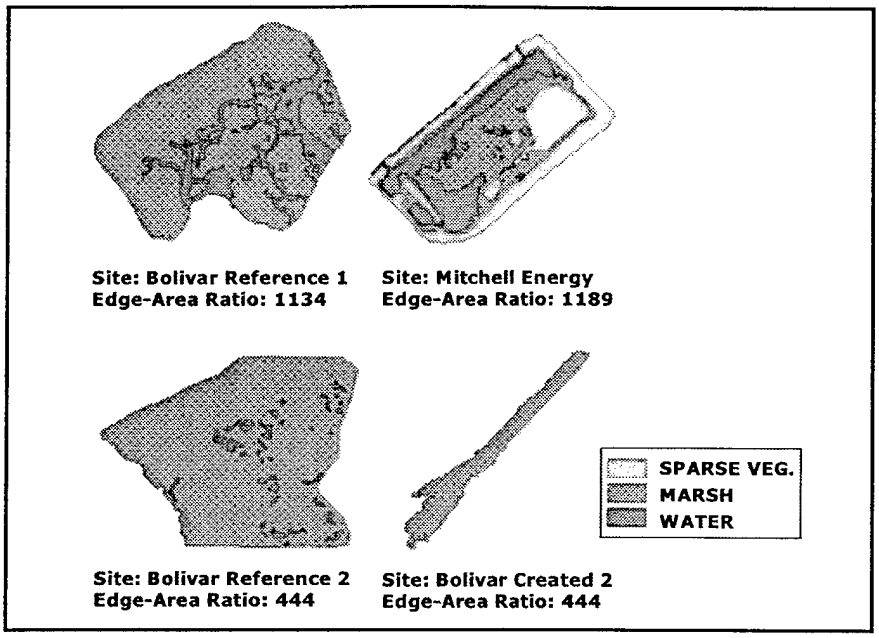

Figure 3. The natural marshes at the left have edge-area ratios similar to those of some dredged material marshes, despite obvious differences in marsh geomorphology, such as fewer tidal creek openings (top) and fewer isolated ponds or depressions (bottom)

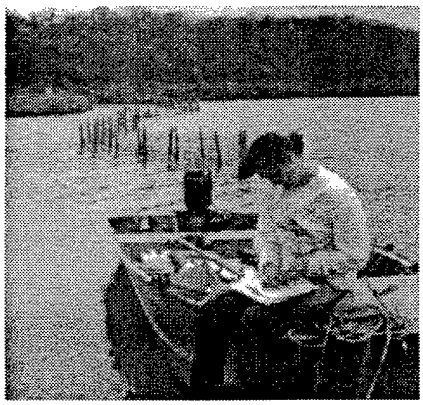

Figure 4. Collecting geomorphology data at the Armand Bayou dredged material marsh in Texas

although this should only be done on an experimental basis until further information is available.

As we move into the new millennium, the Corps will continue to service the nation's dredging needs. Beneficial use of dredged material for marsh creation can make a real contribution to recently called-for national net wetland gain, and research results can contribute to the marsh creation process.

Dr. Bill Streever joined the Wetlands Branch of the U.S. Army Engineer Research and Development Center in 1998. Prior to that, he taught undergraduate and graduate students at the University of Newcastle in Australia, where he also developed a wetland restoration research program that included studies of plants, fish, invertebrates, and economics. Streever earned his B.S. and Ph.D. degrees from the University of Florida, where he undertook research on wetlands created from phosphate mined lands. Before attending the University of Florida, he worked for eight years as a commercial oil field diver in the Gulf of Mexico and the South China Sea. His first book, a scientific travelogue entitled *Bringing Back the Wetlands*, was released by Sainty and Associates Publishers in March 1999, while his second book, an edited volume entitled *An International Perspective on Wetland Rehabilitation*, was released by Kluwer Academic Publishers in July 1999.

Calendar of Events — 2000

Jun 5-9, Annapolis, MD, Wetlands PROSPECT Course: Fundamentals of Wetland Ecology.
POC: *John.P.Buckley@HND01.usace.army.mil*

Jun 26-30, Orlando, FL, Wetlands PROSPECT Course: Wetland Mitigation Banking.
POC: *John.P.Buckley@HND01.usace.army.mil*

Aug 7-11, Annapolis, MD, Wetlands PROSPECT Course: Fundamentals of Wetland Ecology.
POC: *John.P.Buckley@HND01.usace.army.mil*

Nov 11-16, Lake Buena Vista, FL, The 7th International Conference on Wetland Systems for Water Pollution Control.
POC: Dr. K. R. Reddy, *krr@gnv.ifas.ufl.edu*

US Army Corps of Engineers

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LEWIS E. LINK, Ph.D.
Acting Director