Guidelines and Standards for Wetlands Restoration and Creation: Charting a Work Unit's Course

by Bill Streever

For over two decades, wetland creation and restoration have been part of the Corps' mission, and throughout this time, the U.S. Army Engineer Waterways Experiment Station (WES) has been conducting research and providing technical advice in support of creation and restoration projects, planning, operations and maintenance, and regulatory responsibilities. Despite the massive amount of information already in circulation, endless questions remain unanswered. While it is easy to come up with research projects that keep scientists busy, it is more challenging to identify those that offer the most benefit to Corps of Engineers projects and regulatory responsibilities. In charting a course for a work unit called "Guidelines and Standards for Wetlands Restoration and Creation," funded as part of Characterization and Restoration of Wetlands Research Program (CRWRP), both needs and opportunities for research had to be considered.

Identifying Needs

Needs were assessed in three ways:

● First, the CRWRP Field Review Group, made up of representatives from District offices and Headquarters, offered input regarding needs around the country. Field Review Group members drew from both extensive personal experience and discussions with colleagues.

● Second, members of the email discussion group RESTORE were queried about their perceptions regarding research needs (Figure 1). RESTORE was established to put Corps employees involved with wetland restoration and creation in touch with one another via email. Currently, RESTORE has about 500 members. Responses to the RESTORE
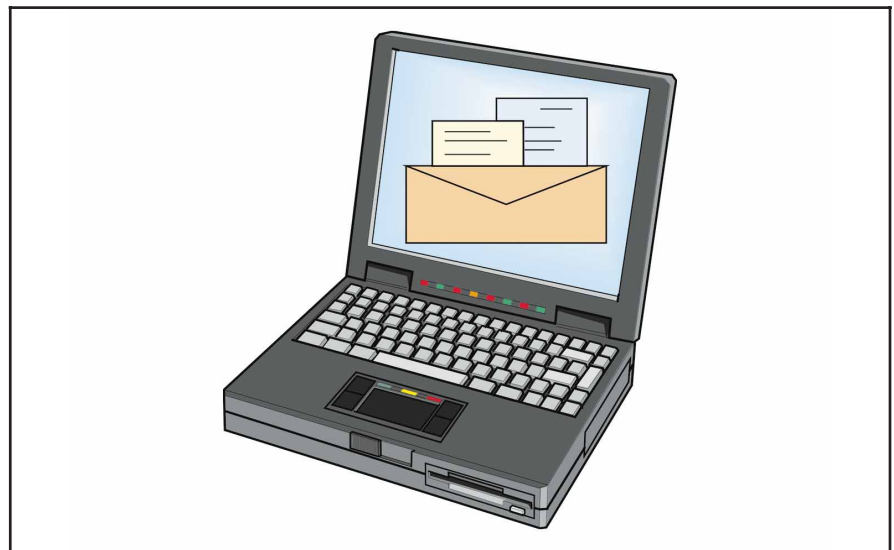

Figure 1. RESTORE, an email discussion group for Corps of Engineers employees involved with wetland restoration and creation, can be reached at *WGRESTORE@mail.wes.army.mil*

query were supplemented by dozens of telephone and face-to-face conversations.

- Third, the scientific and conservation literature was reviewed to identify key issues.

Linking Needs and Opportunities

Once needs are identified, they can be linked to opportunities. These opportunities come in many forms, including:

- Academics and graduate students in search of funding to support projects relevant to Corps needs.
- Existing research projects within the Corps that can be expanded to meet the needs of the Restoration and Creation work unit.
- Interagency interest that can supplement Corps efforts.
- Existence of information that can satisfy needs if it is converted to an appropriate format.

By communicating with both researchers and end users of the products that come from research, obvious links between opportunities and needs arise. The payoff for a relatively small amount of effort in terms of communication is improved cost-effectiveness— a better product for the dollars spent.

Needs

Not surprisingly, a wide range of needs was identified, including such things as research on plant diversity in restored and created wetlands, development of specifications for structures used in wetland projects, development of practices that will effectively in-volve local communities in wetland projects, development of methods to incorporate habitat heterogeneity into wetlands created from dredged material, and development of methods for creating seepage slope wetlands. Regulatory staff focused on a need for reasonable and effective performance standards (or success criteria) for compensatory mitigation that could be included as special conditions in Section 404 permits. Ancillary to this was a need for follow-up: are compensatory mitigation projects meeting performance standards, and if so, are they functioning appropriately in ways that go beyond required performance standards? Some regulatory, planning, and operations and maintenance personnel stressed the need to develop specific practices or guidelines for restoration and creation that would not significantly increase costs or time requirements. The scientific and conservation literature recognizes needs for a better understanding of long-term development of created and restored wetlands, development of better methods for wetland creation and restoration, improved permit compliance tracking, and a better understanding of wetland performance "trajectories" (a topic closely related to development of performance standards).

From Needs and Opportunities to Specific Projects

How do general needs translate into specific projects? Comments from Corps staff make it clear that there is no single issue or wetland type that should receive the undivided attention of the Restoration and Creation work unit. With that in mind, a number of needs were selected, opportunities for effective research were matched with these needs, and the overall work unit effort for the year was divided among many projects. These projects include the following:

- As a start toward improving **performance standards** used in Section 404 permits, performance standards used around the country were reviewed (Figure 2). Regulatory staff members around the country participated by providing copies of permits and guidelines. This review, along with a method for developing better regional and type-specific performance standards through a workshop approach, is being published as a technical note. The next logical step will be to field test existing and proposed performance standards by collecting data on overall wetland performance in sites that meet performance standards.
- It may be possible to use functions or variables identified by the **hydrogeomorphic (HGM) approach** to wetland assessment as performance standards for compensatory wetlands. Because Corps and Natural Resources Conservation Service (NRCS) staff members in North Dakota are actively applying HGM and are interested in HGM research, an opportunity arose to look into the

Figure 2. Is this salt marsh creation project successful? Performance standards are useful in assessing success

usefulness of HGM variables or Functional Capacity Index (FCI) scores as performance standards. This summer, the HGM approach will be applied to a number of prairie pothole wetlands in North Dakota to evaluate consistency among users, to determine if HGM assessments reflect development of restored prairie pothole wetlands over time, and to determine if there is a relationship between currently used performance standards and HGM variable and FCI scores.

● **Headcutting** has led to incised channels and lowered water levels in many rivers. As a consequence of lower water levels, surrounding wetlands drain more quickly. Much of the Wolf River, near Memphis, Tennessee, is impacted by headcutting, and surrounding bottomland hardwood forests are drying out. Proposals for hydrologic restoration are being considered, but data

on the extent of impacts is needed. A Tennessee Technological University professor and graduate student will undertake tree borings, groundwater monitoring, bird surveys, vegetation surveys, and HGM assessments to compare conditions above and below stretches of the river impacted by headcutting. Results will provide input to the design of restoration efforts. More importantly, results will provide a baseline to determine effectiveness of restoration efforts, giving feedback that will guide future efforts to restore damage related to headcutting throughout the country.

● Over the past 20 years, creation of salt marsh habitat on **dredged material** has become an almost routine practice. However, the scientific and conservation literature continues to identify differences between salt marshes created from dredged material and natu-

ral salt marshes. Some of these differences are reflected in bird, fish, and invertebrate communities, but the evidence suggests that biological differences reflect differences in geomorphic characteristics, such as topography, elevation, and density of ponds and tidal creeks. As part of development of the HGM regional guidebook for estuarine fringe wetlands in Texas, data believed to reflect wetland function will be collected from a number of natural salt marshes along the Texas coastline this spring. This effort provides an opportunity to better understand the differences between natural and created salt marshes. By dovetailing the sampling of salt marshes created on dredged material into the existing reference wetland sampling program for HGM guidebook development, an extensive comparison of important variables will be possible at a reasonable cost. This comparison will be accompanied by a review of existing literature looking at success of wetlands created on dredged material. The review will summarize differences in the ways that success is defined by different authors and identify biological and geomorphic differences between these created wetlands and natural wetlands. Ultimately, data collection and a review of the literature will lead to recommendations for improved design and construction methods. A future step

forward would involve testing of recommended methods.

- **Long-term sustainability** of restored and created wetlands is an issue frequently discussed in the literature, and one related to performance standards, but funding cycles and total available dollars for research make long-term monitoring difficult. However, opportunities exist to revisit sites that were subjected to intensive monitoring in the past. In a study in North Carolina, several created sites varying in age from 10 to 21 years were intensively sampled for vegetation and invertebrate fauna in 1994; this study and other similar studies suggested that created marshes undergo long-term development for 10-20 years or longer. This year, sites sampled in 1994 will be resampled. Methods used in resampling will be identical to those used in 1994, and results will contribute to a better understanding of long-term development of created wetlands.

- Many restoration ecologists believe that plant stock should come from local sources to preserve **genetic integrity**. At some Districts, this belief is reflected in guidelines for wetland projects that call for use of local plant stock. However, unavailability of local plant stock in some regions has led to planting of vegetation imported from other regions. At least one study attempting to look at genetic diversity via allozyme analysis could not detect differences in smooth cordgrass (*Spartina alterniflora*) that originated from different locations. However, allozyme analysis is notoriously insensitive to intraspecific genetic variability. The WES Nucleic Acid Research Laboratory is using Amplified Fragment Length Polymorphism (AFLP)—a method much more sensitive than allozyme analysis—to compare DNA signatures of smooth cordgrass from natural marshes in Alabama and created marshes in Alabama that were planted with stock from other states (Figure 3). Data from this study, along with data from similar studies conducted by other laboratories, will provide guidelines about the impact of using different plant sources on preservation of genetic diversity. If differences in DNA signatures are present, a next logical step will be to look for ecological differences related to different genetic backgrounds.

- Many opportunities exist to use past experience or existing data to generate guidelines and standards useful to Corps District staff. One approach is to generate **example contract specifications** that can be used as a template for actual projects. A contract specification template has been prepared for projects using geotextile tubes in wetland creation, and plans are in place to develop example contract specifications for planting projects. Another approach is to summarize existing knowledge in a succinct and accessible form for use by Corps staff. The Massachusetts-based

Figure 3. The WES Nulcleic Acid Research Laboratory is using Amplified Fragment Length Polymorphism (AFLP) to look for differences in genetic signatures in smooth cordgrass

Manomet Center for Conservation Sciences, working through the Restoration and Creation work unit, has agreed to prepare guidelines for designing sites to attract and support various wading and shore birds, and plans are in place to develop a technical note providing guidelines for several approaches to community involvement in wetland creation and restoration based on past experience. Because these approaches rely on existing data or past experience, they can produce guidelines at very low costs.

The "Three C's"

The work outlined here includes projects spread across the United States and across several wetland types. No one researcher could have the expertise to undertake all of this work independently. The key to the success of the work unit is the "three C's"–communication, cooperation, and collaboration. In the future, as the work unit develops, it is hoped that more District staff can become directly involved, both by providing feedback on usefulness of work unit products and through direct participation in project design, site selection, data collection, and data interpretation. Ideas are always welcome—only District staff have a clear idea of what is needed and where it is needed.

Dr. Bill Streever joined the Wetlands Branch of the U.S. Army Engineers Waterways Experiment Station in March 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. While in Newcastle, he worked closely with the Kooragang Wetland Rehabilitation Project by advising managers on scientific issues. 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 and on the ecology of Florida's flooded caves. 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 popularization of wetland science and conservation called *Bringing Back the Wetlands*, was published in March 1999.

Wetland Erosion Protection Structures: How Low Can You Go?

by Jack E. Davis and Bill Streever

Creating wetlands with dredged material provides habitat for a variety of animals, recreational opportunities for people, and a dredged-material placement option for U.S. Army Engineer Districts. However, when dredged material is used to create wetlands, structures are often required to protect against erosion. These structures can add significant costs to projects (Figure 1). One way to lower the cost of these structures is to lower their elevations—the lower the

Figure 1. Newly constructed marsh requiring breakwater to dissipate wave energy; the breakwater is visible from just left of the bottom center, stretching to the left and arcing around the newly constructed marsh

elevation, the lower the cost. But how low can you go before compromising the structure's ability to protect the wetland? Fully developed guidelines are not available, but a demonstration project near Aransas National Wildlife Refuge in Texas suggests that structures constructed at or slightly above the local, annually averaged daily high tide may be sufficient for similar projects along the Texas coast.

Two sites near the Aransas National Wildlife Refuge were built in 1993 as demonstration projects in an area exposed to fetches up to 14 miles. Wind speeds and directions gathered between 1985 and 1993 at the Port Aransas, TX, National Atmospheric and Oceanographic Administration anemometer averaged between 10 and 15 knots, with the strongest recorded across-water winds being less than 30 knots. Estimated wave heights during the strongest winds were 2-3 ft. In this climate, erosion of a marsh creation project without protective structures is certain.

At the first of the two sites, Site 127A, a trapezoidal-shaped riprap breakwater was built with an elevation of +3.5 ft mean low tide (MLT, Corps of Engineers datum), or more than 1 ft above the local annually averaged daily high-tide mark (Figure 2, top). Not surprisingly, the smooth cordgrass (*Spartina alterniflora*) wetland planted behind the breakwater is flourishing, with no evidence of erosion. At the second site, Site 128, a breakwater was constructed using geotextile tubes with a 22.5-ft circumference (Figure 2, bottom). The crest elevation of the tubes ranged from +2 ft MLT to +2.4 ft MLT—within inches of the average high-tide mark. Despite the relatively low elevation of the geotextile tube breakwater, smooth cordgrass planted at elevations of about +1 ft MLT to +2 ft MLT flourishes, with no signs of erosion. To all appearances, the lower elevation of the breakwater at Site 128 is offering as much protection as that offered by the higher riprap breakwater at Site 127A.

The graphs in Figure 3 show water levels for 1996 and 1997 in the project vicinity. Superimposed on the water level heights shown in Figure 3 are the crest elevations of breakwaters at Site 127A and Site 128. The riprap breakwater used at Site 127A, with a crest elevation of 3.5 ft MLT, would seldom be completely submerged, but high tide levels are frequently above the crest of the geotextile tube breakwater at Site 128. In fact, because the daily tidal range is only a few inches, while the meteorologically driven tidal range is more than 2 ft, the crest of the geotextile tube breakwater at Site 128 can be continuously submerged for several weeks at a time. Nevertheless, erosion is not a problem at Site 128.

One explanation for the effectiveness of a relatively low

Figure 2. The riprap breakwater at Site 127A (top) has a crest elevation of +3.5 ft MLT, while the geotextile tube breakwater at Site 128 (bottom) has a crest elevation ranging from +2.0 to +2.4 ft MLT
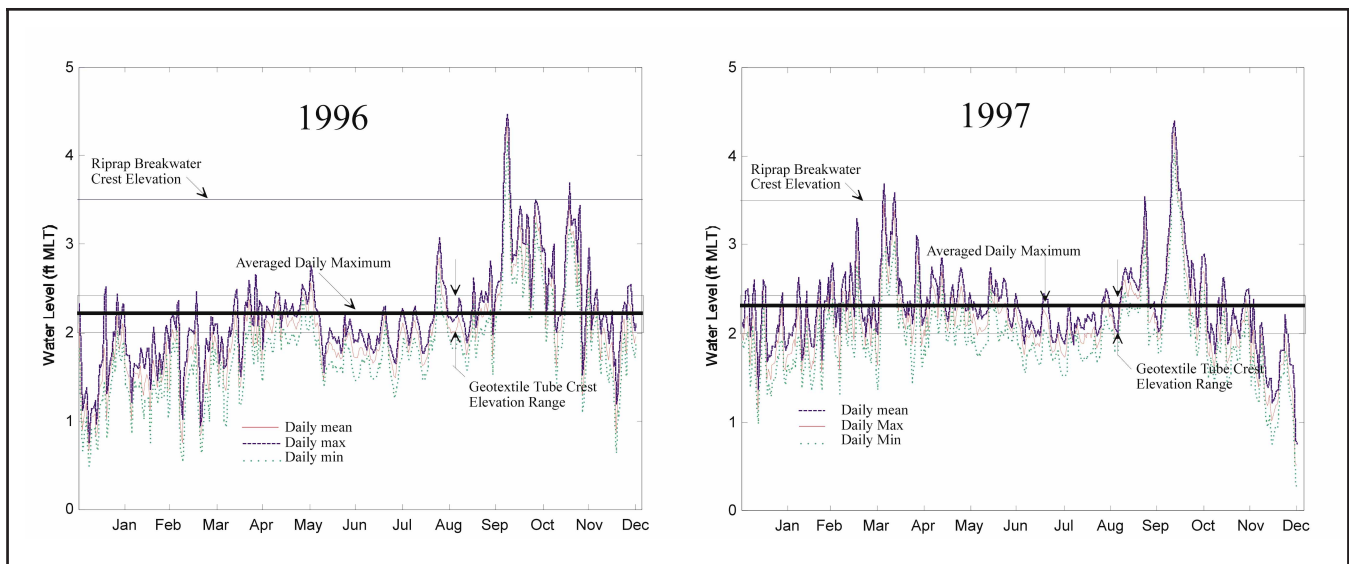
Figure 3. Crest elevations of marsh protection structures relative to 1996 (left) and 1997 (right) water levels and annually averaged daily high tide

structure is that it protects the root zone of the vegetated marsh. That is, when water levels are low, the structure prevents waves from undermining vegetation at the seaward edge of the marsh. When water levels are high and the crest of the structure is underwater, waves propagate into the marsh and wave energy is dissipated as waves pass through plant stems and leaves. Whether the water level is low or high, the root zone does not receive the brunt of the wave energy, and erosion does not occur.

Clearly, if the effectiveness of low structures results from protection of root zones, structures intended to protect created wetlands dominated by high marsh species, such as saltwort (*Batis maritima*) or sea-oxeye daisies (*Borrichia frutescens*), will have to be higher than structures intended to protect low marsh species, such as smooth cordgrass. High marsh species grow at higher elevations than smooth cordgrass, so the root zone of high marsh species will be higher than that of smooth cordgrass and higher structures will be needed to prevent erosive undercutting.

Many unknowns remain, not the least of which is the extent to which the observations at Site 128 can be generalized to other situations. Before structures can be routinely designed at low levels, guidelines will need to be developed that account for water-level return frequency and distribution, incident wave energy, influence of structure design on wave dissipation, wave-dissipation qualities of vegetation, and the ability of root systems to retain sediment. In part, guidelines can be developed from computer and physical models, but demonstration projects will need to be undertaken at several locations in order to validate models. Until then, a firm answer to the question of how low you can go will remain beyond reach, and designers will have to rely on experience and documentation of projects such as that of Site 128 near Aransas National Wildlife Refuge in Texas when establishing structure elevations.

Jack Davis is a research hydraulic engineer with the Coastal Sediments and Engineering Design Division in the Coastal and Hydraulics Laboratory of the U.S. Army Engineer Waterways Experiment Station in Vicksburg, MS. He holds an M.S. degree in Civil Engineering from the University of Texas at Austin and is currently a Ph.D. candidate in the Ocean Engineering Program at Texas A&M University. Mr. Davis has been at the R&D center for 15 years, spending 5 years studying reservoir water quality, 2 years studying wind-wave generation and propagation, and 8 years in coastal engineering and project design, including coastal wetland restoration/creation.

In this issue . . .

✎ **Guidelines and Standards for Wetlands Restoration and Creation**

✎ **Wetland Erosion Protection Structures**

These articles focus on experience and data collected under "Guidelines and Standards for the Wetlands Restoration and Creation" work unit at the Waterways Experiment Station.