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USE OF DREDGED MATERIAL TO CONSTRUCT WINTER WHOOPING CRANE HABITAT

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Abstract: Aransas National Wildlife Refuge (ANWR) and nearby coastal marshes serve as the winter home for the only natural flock of whooping cranes (Grus americana). In recent years shoreline erosion and the subsequent loss of wintering habitat have been observed on the refuge adjacent to the Gulf Intracoastal Waterway (GIWW). In 1988 the U.S. Army Corps of Engineers (USACE) District, Galveston, Texas, and U.S. Fish and Wildlife Service (USFWS) entered into an informal agreement to attempt to slow shoreline/habitat loss on the refuge. Efforts to curtail habitat loss have included armor ing the most erosive reaches with temporary concrete erosion control structures and using articulated concrete mats to armor severely eroded reaches. Most recent efforts have been directed at determining if dredged material removed from the GIWW during routine channel maintenance could be used to construct winter crane habitat. One experimental site was constructed in 1991 by Mitchell Energy Corporation and 2 in 1993 by USACE. Current plans call for the long-term monitoring of the sites to determine the relative success of the habitat creation effort. A comprehensive biomonitoring program is being developed by researchers at the USACE Waterways Experiment Station (WES) to track the long-term development and to characterize habitat conditions and wildlife use of the experimental sites.

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Key words: Aransas National Wildlife Refuge, dredged material, ecological monitoring, Grus americana, habitat creation, whooping cranes.

The establishment of ANWR in 1937 helped protect and conserve the wintering habitat of the whooping crane. In the winter of 1938, the whooping crane population was estimated at 29 individuals and only 2 small flocks survived in the wild. During the past 57 years the population has increased slowly to total 158 individuals in the 1995 winter (T. V. Stehn, unpubl. data). The protection, conservation, and management of the wintering grounds at Aransas is and will continue to be paramount to survival of the species in the wild.

The GIWW is a federal navigation canal 38 m wide by 4.7 m deep for waterborne commerce located between Texas and Florida; it was constructed through Aransas in 1944. Construction of the GIWW, past dredged material disposal practices, and shoreline erosion created a net loss of 465 ha of whooping crane habitat at ANWR (Ramirez et al. 1988). Net losses inside the critical habitat from 1930 to 1986 have amounted to 841 ha, equaling an 11% loss in a study corridor 1,830 m wide centered on the GIWW (Sherrod and Medina 1992).

Critical habitat on the wintering grounds adjacent to the GIWW is being lost to erosion at a rate of 1.0–1.6 ha annually (Stehn 1987, USACE 1988) with total losses at ANWR exceeding 93 ha (Stehn 1987). Rate of shoreline erosion is 0.7–1.2 m per year along some of the more erosive reaches (Stehn 1987, USACE 1988). Since 1940, the GIWW shoreline has receded approximately 28 m on either side of the channel (Stehn 1987).

Loss of critical habitat in these areas represents a potentially threatening situation to the survival of the species on the refuge because of the proximity of winter crane territories to the GIWW. In winter 1994–95, 19 of 46 (41%) of the total adult crane territories adjoined the GIWW (Stehn 1995). Exact cause and rate of shoreline/habitat loss are presently unclear, but loss is believed to be caused by natural wave (fetch) and current action, wakes thrown up by marine traffic using the GIWW, and, to some extent, past dredged material disposal practices (Stehn 1987, Zhang et al. 1993). This paper describes efforts taken to (1) stop habitat loss on the wintering grounds caused by shoreline erosion and maintenance dredging disposal practices, (2) create additional marshlands for whooping cranes by using dredged material, and (3) formulate long-term plans for the ecological monitoring of the created marshes.

STUDY AREA

The GIWW passes through 68 km of whooping crane critical habitat in areas regularly used by wintering cranes. This includes an 11-km reach by the Welder Flats Coastal Preserve next to Shoolwater Bay and a 19-km reach through the ANWR between Aransas and San Antonio Bays (Fig. 1). Dredged material was used to create habitat in Mesquite and San Antonio Bays adjacent to ANWR.

RESULTS AND DISCUSSION

Shoreline Erosion

The USFWS and USACE-Galveston conducted several activities from 1989 to 1992 aimed at stopping or slowing erosion of critical whooping crane habitat. The most significant of these was the initiation of an on-going study under
Section 216 of the 1970 Flood Control Act, which is investigating the feasibility of relocating the GIWW to a different route. Temporary erosion control measures (e.g., concrete bag retaining walls, posting signs within the confines of the refuge urging boat operators to operate at speeds which would produce little or no wakes) were initiated in 1989 as a stopgap measure on several of the more erosive reaches (i.e., those that would be irreversibly modified before the completion of the Section 216 study). Approximately 2,652 m of erosive shoreline were protected from 1989 to 1992 by use of more than 57,000 bags of cement in a huge volunteer effort involving government, private corporations, and hundreds of individuals.

In May 1993 an agreement was reached between the USFWS and USACE-Galveston, which called for the arming of some to the more erosive reaches with technology regularly used by USACE on inland waterways. By 1995 approximately 5,486 m of shoreline had been protected with articulated concrete mats laid on geotextile fabric. Mats were anchored/linked with polyester cables which allow the mats to move and conform to existing land features. Current plans call for the arming of an additional 610 m annually until the Section 216 study is completed and implemented.

Creation of Habitat from Dredged Material

More permanent solutions to the problem of habitat loss included investigating the use of dredged material removed from the navigable channel during routine, scheduled maintenance to (1) construct additional winter habitat and (2) construct erosion control structures for protecting existing habitat. In 1989 a cooperative study between USACE-Galveston, USFWS-ANWR, and WES was begun to survey the area to determine the feasibility of using dredged material removed from the GIWW during routine channel maintenance to protect some of the more erosive reaches. The goals of the initial study were to (1) characterize vegetation and wildlife use on some of the more erosive reaches and (2) conduct the preliminary engineering studies to determine the feasibility of using dredged material in a beneficial manner.
to construct additional winter habitat. A 50-year dredged material disposal plan is being developed cooperatively between the USFWS and USACE-Galveston. This plan will call for use of dredged material to create an additional 653 ha of winter habitat.

The first large-scale attempt to create winter whooping crane habitat with dredged material was undertaken in 1991 by the Mitchell Energy Corporation (MEC). A 5.3-ha site was constructed on the bayside of Bludworth Island (Fig. 1) by use of material removed as part of a dredging operation (channel establishment) in the Mesquite Bay area. The site was planted with species native to the Texas Coastal Bend. In 1993, MEC constructed a 3.6-ha site which adjoined the original construction effort. Both sites were protected with articulated concrete mats connected with polyester cables. One-year monitoring on the first site indicated ground coverage of approximately 99% and 89% for low and high marsh species, respectively (C. Belaire, Belaire Consulting, Inc., Rockport, Tex., unpubl. data). Smooth cordgrass (*Spartina alterniflora*) was the dominant species on the low marsh areas of the project and saltmeadow cordgrass (*S. patens*), saltgrass (*Distichlis spicata*), seaside paspalum (*Paspalum vaginatum*), and saltwort (*Batis maritima*) dominated the drier, high marsh areas. Preliminary observations suggest that the MEC wetland is maturing well, and whooping cranes were observed in the created habitat 4 times from 1991 to 1994 (2 cranes in January 1991, 5 cranes in March 1993, 2 cranes in November 1994, and 2 cranes in December 1994) (T. V. Stehn, unpubl. data).

A fisheries study of the created Mitchell habitat compared with natural marshes, seagrass beds in shallow bays, and unvegetated shallow bay bottom showed the new marsh to benefit fisheries (Rozas et al. 1994). Salt marsh and seagrass habitats supported significantly greater densities of most species. Therefore, replacing open bay bottom with marsh and seagrass habitats should have a positive effect on most species that were dominant in the study area. Even though some open bay habitat will be lost by creating new marsh, the area replaced by marsh is small relative to the total area of open bay habitat in the vicinity, and species that use shallow unvegetated bottom will likely find suitable habitat near constructed marshes (Rozas et al. 1994). If marshes that are functionally equivalent to natural marshes can be constructed, the increased benefit of enlarging the habitat area for fishery and forage species that use marsh systems should outweigh the loss of open bay habitat (Rozas et al. 1994).

In summer 1993, the USACE-Galveston began construction of 2 additional sites by using material obtained from ongoing dredging operations in the area. The 2 sites were located east of False Live Oak Point (Disposal Area [DA] 127a) and east of an unnamed dredged material island across from the opening to Mustang Slough (DA 128) (Fig. 1). The False Live Oak 9.3-ha site was contained within an earthen levee. Three openings were constructed through the levees to facilitate water exchange on the site and a riprap breakwater (stone) was constructed around the bay side to protect the developing marsh from fetch. The second 8.5-ha site, DA 128, was constructed at an existing dredged material disposal site and armored with large diameter, geotextile grout tubes filled with dredged material. Experimental sites were planted in 1993 by consultants under contract to the USACE-Galveston with native salt marsh species common to the intertidal marshes of the Texas Coastal Bend. Both sites were allowed to consolidate and dewater for 2 years while plans for the long-term ecological monitoring of the sites were developed by personnel from USFWS-ANWR, USACE-Galveston, and WES.

**Long-term Monitoring**

Biologists from the USFWS-ANWR, the USACE-Galveston, and the WES have developed a long-term program aimed at monitoring 3 biological aspects of the experimental sites. Monitoring data will be used to evaluate the success or failure of the habitat creation effort and to provide information for scientists and engineers charged with future habitat creation efforts. Long-term ecological monitoring of the project area will involve sampling efforts to assess (1) the development of vegetation on the experimental sites, (2) the use of the experimental sites by avian species, and (3) macrobenthic and invertebrate abundance and composition on experimental sites.

Control sites include open bay habitat in San Antonio and Sundown Bays and saltmarsh on the north end of Sundown Bay (Fig. 1). These natural communities will be compared with the created marshes and open bay habitats that existed prior to marsh creation.

**Vegetation**

Development of vegetation on the experimental sites will be monitored annually during the study by use of remotely sensed data and conventional field sampling techniques. Habitat types will be manually delineated on aerial photos and digitized into a Geographic Information System (GIS) for spatial analyses. Percent coverage of the various habitat elements/components (e.g., open water, planted vegetation, bare ground, tidal flats, and tidal channels) will be determined for each year of the study and used to track the development of the vegetation on the experimental sites.
Avian Use

Avian use of the experimental sites will be monitored bimonthly on both control and experimental sites. Composition and abundance of avian species will be determined for comparisons of avian diversity. Two fixed-width transects have been established on the control and experimental sites to identify (1) and tally all avian species occurring on each site, (2) how the sites are being used (e.g., feeding, loafing, or resting), and (3) what habitat types (e.g., tidal flats, open water, or low marsh) within the sites are being used. Richness and evenness indices will be calculated and used to compare avian diversity on the sites and evaluate whether the experimental sites are mimicking the control sites.

Macrobenthos/Invertebrates

Quarterly macrobenthic/invertebrate sampling will be aimed at (1) investigating taxonomic composition, taxa richness, and total abundance of macrobenthic/invertebrate species on control and experimental sites and (2) determining if the types and numbers of macrobenthic/invertebrate species on and around experimental sites are similar to those found on control sites. Taxonomic composition, taxa richness, and total abundance (animals per m²) will be estimated for each of the sites (experimental and control) and used to determine if significant differences exist.

The 2 main concerns that will be addressed in our field sampling are (1) are macrobenthic and infauna abundance and composition on an experimental site comparable to macrobenthic and infauna abundance and composition on a control/existing site, and (2) how did the loss of open water, shallow bay habitat affect macrobenthic and infauna abundance and composition (how many and what kinds of species did we impact by building the experimental site?). Primary efforts will be directed towards the macrobenthic component (e.g., fish, crabs, and shrimp) because of its importance to wintering cranes as a potential food resource.

Permanent macrobenthic trap stations were established during summer 1995 and permanently located by use of a Global Positioning System. Macrobenthic/invertebrate data will be collected quarterly and will involve the use of 1.5- x 1.5-m portable drop nets, a 7.5-cm PVC cylindrical push corer/sampler, and commercial crab traps. We will run 3 drop net traps per site per day and trap for 4 consecutive days each quarter. This design will provide us with a minimum of 12 samples per site per quarter (36 total samples per quarter) and 144 samples per year.

We have established 27 permanent infauna sampling points on the 3 study sites. Infauna samples will be collected with the push corer, processed through a 0.5-mm sieve, and preserved in the field. Identification and analysis of macrobenthic and infaunal samples will be done by invertebrate biologists in the Coastal Ecology Group of the Environmental Laboratory at WES.

Crab Abundance

Crab abundance and distribution on the 3 sites will also be monitored quarterly with commercially available crab traps. Four permanent trap sites were established in August 1995 on each of the 3 study sites to determine the species, size, and numbers of crabs that will be available to wintering cranes. Crab traps were baited with raw chicken each morning and checked once daily for 4 consecutive days. Crabs were identified to species, sexed, measured, and released back on the site at the end of each day.

Home Range

Another important aspect of the study will involve use of observation data collected by ANWR biologists to calculate winter home range and territory size for cranes using the refuge. Observation data will be digitized into a GIS and used to calculate home range/territory size and shape according to several accepted methods. Vegetation sampling (i.e., species dominance, species frequency, vegetation height, density, and coverage) within home ranges/territories and core areas will be conducted in the third and fourth years of the study to contribute to an understanding of the structural characteristics of winter habitat. Intensive field sampling within home ranges/territories will provide insight into the structural characteristics of winter habitat and provide a model/template to guide future habitat creation efforts.

Preliminary Field Sampling

Preliminary analysis of drop net data collected in summer 1995 suggests that a diverse assemblage of species (vertebrate and invertebrate) is already present on the study sites. Dominant species on the 3 sites included white shrimp (Peneaus setiferous), grass shrimp (Palaeomonetes pugio), and blue crabs (Callinectes sapidus). Analyses of drop net data indicated that DA 128 had the largest number of species (7) but the DA 127a site had the highest number of individuals (86). The Sundown Bay control site had the fewest species (5) but the greatest number of white shrimp. DA 127a had the greatest number of crabs (23).

Analyses of infauna data indicated that the Sundown Bay control site had the greatest number species (9) and the greatest number of individuals (20). Species identified in infauna samples from the 3 sites included clam worms
(Nereis succinea), an amphipod (Ampelisca abdita), polychaete (Laeonereis culveri), lunar dove shell (Mitrella lunata), mud shrimp (Callianassa spp.), polychaete worms (Capitellidae), unidentifiable polychaetes, blue crabs, shrimp (Acetocina [Retusa ] caniculata), dwarf surf clam (Mulinia lateralis), and tube-building worm (Diopatra cuprea).

Sixty-nine blue crabs were captured on the 3 study sites during the sampling period. Crab abundance was greatest on the DA 128 site (31) and least on the Sundown Bay control site (13). Twenty-five blue crabs were trapped on DA 127a during the sampling period.

CONCLUSIONS

Development of the MEC sites appears promising and the sites appear to be progressing as expected (T. V. Stehn, unpubl. data). Information obtained from data collected on both the MEC and USACE sites in subsequent years will be used to better understand seasonal and annual developmental variation among the sites. Baseline data collected in the first year of this study will be used to make comparisons among sites and years to gain insight into the development of the experimental sites and ultimately to evaluate the success/failure of the habitat creation effort. Data collected as part of this study will also be used to determine the feasibility of conducting similar efforts in the future. We hope that USFWS and USACE researchers can establish some fundamental design criteria that can be used to guide future habitat creation efforts. A successful habitat creation effort at Aransas would provide much needed winter habitat for the wild whooping crane population and would benefit both the USFWS by identifying a mechanism for protecting erosive shoreline and the USACE-Galveston by confirming a cost-effective mechanism for the safe, beneficial use of dredged material.

LITERATURE CITED


