Historical Loss of Whooping Crane Habitat on the Aransas National Wildlife Refuge

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Abstract: In October 1989, researchers at the U.S. Army Engineer Waterways Experiment Station (WES) initiated a project to investigate the historical loss of critical whooping crane (*Grus americana*) habitat on the Aransas National Wildlife Refuge. Vegetation on the area was categorized into 11 habitat types and manually delineated on aerial photos of the area from 1930, 1957, 1986, and 1988. Habitat type maps for each year were digitized into a Geographic Information System (GIS) database that included soils, topography, and National Wetland Inventory data. Preliminary GIS analysis of habitat type data indicated a progressive loss of 2 habitat types, tidal flats and tidal ponds, and a gradual increase in the marsh vegetation type. In 1930 and 1957, tidal flats comprised approximately 7% (454 ha) and 8% (500 ha) of the study area, respectively, but that number decreased to approximately 2% (134 ha) of the area in 1988. Marsh vegetation covered approximately 18% (1,214 ha) of the area in 1930, 17% (1,123 ha) in 1957, and 21% (1,369 ha) in 1988. A decrease in the number of semi-permanent ponds was also observed from 1930 to 1988.

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The Aransas National Wildlife Refuge was established in 1937 by President Franklin D. Roosevelt (Executive Order No. 77841) to protect and conserve the wintering habitat of the whooping crane (*Grus americana*). At that time the native crane population was estimated at 29 individuals (U.S. Fish and Wildl. Serv. 1986), and only 2 small flocks survived in the wild. One was the migratory population which wintered at Aransas (18 individuals), and the second was a smaller, non-migratory flock of 11 individuals which lived in the White Lake area of Louisiana (Doughty 1989).

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Over the past 50 years, the combined work of the U.S. Fish and Wildlife Service (USFWS) and the Canadian Wildlife Service (CWS) has resulted in a steadily increasing population of approximately 142 individuals (T. Stehn, pers. commun.). The target density (40 nesting pairs) called for in the Whooping Crane Recovery plan (USFWS 1986) was reached in 1992 and continued growth is predicted for the next 20 to 30 years (Miller et al. 1974, Binkley and Miller 1983, Boyce 1985, Boyce and Miller 1985, Nedelman et al. 1987). If this trend in population growth continues, the protection and management of the wintering grounds at Aransas will be paramount if the species is to survive in the wild.

Shoreline erosion on several areas adjacent to the Gulf Intracoastal Waterway (GIWW) is now threatening critical wintering habitat. In 1988 the U.S. Army Engineer District in Galveston, Texas, investigated shoreline erosion along a 21.3 km reach of the GIWW which passes through the southeastern portion of the refuge and reported annual erosion rates of 0.6–0.9 m along unprotected reaches of refuge shoreline and losses of 0.1–0.3 m in reaches protected on the southeast by barrier or disposal islands (U.S. Army Engineer District, Galveston, 1988). Erosion rates of 0.8 m per year (Stehn 1988) have been reported by USFWS biologists working on the refuge and are generally in agreement with those reported by the Galveston District.

In October, 1989, the U.S. Army Engineer District, Galveston, requested that researchers at the U.S. Army Engineer Waterways Experiment Station (WES) investigate habitat loss of the refuge and to determine if dredged material removed from the GIWW during routine maintenance could be used to construct erosion control structures and additional areas of winter habitat. Biologists from the Environmental Laboratory (EL) at WES were tasked with characterizing the pre-project biota of the area to establish baseline biological conditions and examining habitat loss through time.

Methods

To determine the historical rate of change in habitat types occurring on the area, we obtained historical sets of aerial photos of the refuge and chose sets that were of appropriate quality, coverage, and scale. A study area was delineated on a portion of the refuge that was clearly visible on the selected photographs and was consistently used by wintering cranes. The study area was approximately 4.7 km wide and encompassed 6,607 ha along both sides of the GIWW from False Live Oak Point to Dunham Bay.

The study area, located along the southeastern portion of the refuge on the Blackjack Peninsula, was bounded on the northeast by McMullen Lake, on the southwest by Dunham Bay, and was between Corps of Engineers Stations 770+000 to 840+000 (mile markers 500-510). This reach of the GIWW was cut through refuge lands in the early 1940s and has several long, narrow barrier islands on the south side of the channel. Several of these islands, which now protect portions of both the GIWW and the refuge, were formed as a result of the construction process. Some of the islands were constructed using material removed from the original channel and have since been leveed and used as confined disposal facilities (CDF's) for the disposition of dredged material. Others were formed as cutoffs from the mainland during original channel alignment and exist in various sizes and shapes along the GIWW.

Vegetation was typical of the salt marsh-tidal communities that occur in the Coastal Bend Region of Texas. The area was dominated by halophytic species such as saltwort (*Batis maritima*), sea ox-eye (*Borrichia frutescens*), and glassworts (*Salicornia* spp.) and was interspersed with numerous tidal ponds, flats, and salt pans. Detailed quantitative studies on the vegetative communities occurring on the refuge are limited but more detailed discussions are available in Jones et al. (1961), Jones (1982), and McAllister (1988).

A thorough field inventory of the vegetation occurring on the project area was not practical given the time and resources available; therefore, habitat type maps were developed using historical aerial photographs and manual photo interpretation techniques. Photos were of varying scales, quality, and film type, and covered a time span of approximately 60 years. Photo interpretation was done using a type F-71 mirror stereoscope (Gordon Enterprises Inc., Calif.), a PS-2a pocket stereo viewer (Air Photo Supply, N.Y.), and a light table.

Habitat boundaries were manually delineated on Mylar overlays and used to make a mosaic on the study area for each set (year) of aerial photos. Delineations of habitat types on aerial photos were based on the texture, color, and relative location of habitats within the project area. Questionable and unclear areas on the photographs were visited during subsequent trips to the refuge to clarify problems encountered during delineation. Completed habitat type maps were checked for accuracy, georeferenced, and digitized into a GIS database.

Results and Discussion

A total of 11 habitat types were identified using field data and aerial photos. Each habitat type used in the delineation process is listed below with a brief discussion of plant associations, the logic used to differentiate the habitat type, and the importance of each type as wintering habitat.

Marsh Vegetation.—Dominant plant species occurring in the marsh area included sea ox-eye, saltwort, glasswort, sea blite (*Suaeda linearis*), and sea lavender (*Limonium nashii*). Other species occurred in pure, monotypic stands in low areas. Saltgrass (*Distichlis spicata*) and salt-flat grass (*Monanthochloe littoralis*) grew in pure associations along the fringe of small ponds and permanently saturated areas, and smooth cordgrass (*Spartina alterniflora*) occurred at waters' edge adjacent to tidal ponds and shallow bays. Some marsh areas which were topographically higher have undergone succession and have started to develop the more brushy, woody, and grass species common to upland areas of the refuge. The relative importance of the marsh vegetation to wintering cranes on Aransas is high and these areas provide foraging, resting, and loafing areas for wintering cranes.

Upland Vegetation.—Upland vegetation in the project area occurred in the topographically higher and more mesic areas. Vegetation was variable but was dominated by various grass, woody, and brush species. Dominant species in the upland habitat type included Gulf cordgrass (*Spartina spartinae*), bluestems (*Andropogon* spp.), live oak (*Quercus virginiana*), yaupon (*Ilex vomitoria*), partridge pea (*Cassia fasiculata*), Hercules club (*Zanthoxylum clava-herculis*), mesquite (*Prosopis glandulosa*), prickly pear (*Opuntia* sp.), and baccharis (*Baccharis halimifolia*). The importance of the upland areas to wintering cranes is not clear and little information exists in the literature on crane use of these areas. However, several authors have reported that the live oak brushlands in the upland areas receive crane use. Cranes have been reported to move into the perimeter of these areas and feed on acorns from the live oaks after the areas have been burned to reduce the mid/understory (Hunt 1987).

Tidal Flats.—The tidal flats occurring on the study area were lower in elevation than all of the other types and were not vegetated. These areas, inundated with bay water on a regular basis, have developed saline to hypersaline conditions which limit plant colonization. Vegetation is sparse in most of the tidal flat areas and salt pans are common. The tidal flats are of critical importance to wintering cranes because they provide optimal foraging conditions when flooded. Tidal flats were easy to delineate on aerial photos because of their appearance.

Tidal Ponds.—Depth and areal coverage of tidal ponds varied, but most were from 0.3 m to 0.91 m deep and between 0.4–2.0 ha in size. These ponds hold water much of the year because of their direct tidal connection with the adjacent bays, and they are important as foraging substrate for cranes wintering on the refuge. The non-tidal ponds are semi-permanent and depend on rainfall and overland flow from the uplands for replenishment. Tidal ponds were differentiated from landlocked ponds during the delineation process by the presence of direct tidal connections. Tidal connections were not always obvious on aerial photos and some had to be verified on the ground during field work.

Semi-permanent Ponds.—The study area was interspersed with hundreds of semi-permanent ponds which were landlocked shallow depressions having no obvious tidal connection. Delineation of these ponds was difficult given the quality of aerial photographs available at the start of our study and the vast number of ponds in/on the study area. The small size of these ponds prohibited accurate delineation of each pond, but because they represented an important winter crane habitat, we felt that they needed to be included in any habitat type maps developed for the area. A classification system was developed in which ponds greater than 0.4-ha in size were delineated as separate polygons and digitized with the habitat data. Ponds smaller than 0.4 ha were divided into 2 separate classes based on size: those less than 0.4 ha but greater than 0.2 ha; and those less than 0.2 ha. The smaller ponds were color-coded depending on size and digitized as point data.

Open Water.—Areas designated as open water included: 1) the shallow water flats between the GIWW and the refuge shoreline; 2) the shallow water zones between the GIWW and the barrier islands/CDF's; and 3) the shallow water areas on the bay side of the barrier islands/CDF's. This included the area around Sundown Bay, Ayres Bay, Mesquite Bay, and San Antonio Bay.

CDF.—This category included any areas which had previously been disturbed or modified by man as a result of dredging. This included the confined disposal facilities on False Live Oak, Rattlesnake, and Bludworth islands. These areas exhibit atypical vegetation and hydrology and were of limited importance to wintering cranes.

Reef/Shoal.—Several reefs/shoal areas were observed during fieldwork and photo interpretation. Delineation of reefs was difficult because of photo quality, water clarity, and depth in the area adjacent to the reef/shoal, the amount of shoal material accumulated around and on the reefs, and the timing of overflights. The importance of reef/shoal areas to wintering cranes has not been studied or reported in the literature.

Tidal Channel.—Several small, shallow channels were observed in the project area during photo interpretation. Field inspection of several of these channels indicated that most were between 13.7–22.8 m wide and from 7.6–91.4 cm deep. A random field sample of several of these small channels indicated most were relatively shallow (45.7–91.4 cm) and all had accumulated excessive amounts of silt. Some of these channels were apparently constructed to improve drainage and freshwater recharge of the marsh and were probably used for foraging by wintering cranes.

Permanent Lake/Slough.—This category included all of the permanent lakes and sloughs of the Blackjack Peninsula (Long Lake, McMullen Lake, Mustang Slough, and Redfish Slough). These water bodies were permanent and apparent on all of the aerial photos. Most of the lakes/sloughs are too deep for crane foraging, except under low tide conditions. However, the shallow water areas adjacent to the shoreline undoubtedly provide almost optimal foraging conditions under normal tidal conditions.

Unidentified.—This designation represented any features (both natural and artificial) that were not readily discernible on aerial photographs.

The most abundant habitat type on the area in all years was the open water category (Table 1). In 1930, open water was followed by the upland vegetation, marsh vegetation, tidal flat, tidal pond, permanent lake-slough, and the reef/shoal categories. In 1957, open water was followed by upland vegetation, marsh vegetation, tidal flat, permanent lake-slough, tidal pond, and the reef/shoal categories. In 1988, open water was followed by upland vegetation, marsh vegetation, permanent lake-slough, tidal pond, tidal flat, and the reef/shoal categories.

The most noticeable change in areal coverage of habitat types was the decrease in the tidal flat and tidal pond types occurring between 1930 and 1988. In 1930, tidal flats composed approximately 7% (454 ha) of the entire study area. In 1957, the coverage of tidal flats increased slightly to 8% (500 ha) of the study area and then decreased over the next 31 years to 2% (134 ha) in 1988. Areal coverage of tidal ponds was 222 ha (3%) in 1930, 188 ha (3) in 1957, and 160 ha (2%) in 1988. Numbers of semi-permanent ponds also decreased during this time period. There were 614 semi-permanent ponds in 1930, 508 in 1957, and 241 in 1988. The decrease in acreage of tidal flats and tidal ponds observed from 1930 to 1988 was accompanied by an increase in the marsh vegetation type. Marsh vegetation covered approximately 1,214 ha (18%) of the study area in 1930, 1,123 ha (17%) in 1957, and 1,369 ha (21%) in 1988.

Although the cause of shoreline erosion and the subsequent loss of wintering habitat is unknown, 2 forms of habitat loss are apparent. Unrestricted wind-generated waves and wakes thrown up by marine traffic using the GIWW impact unprotected reaches and have resulted in serious shoreline/habitat loss. Continual

Table 1. Historical change in whooping crane habitat on the Aransas National Wildlife Refuge from 1930 to 1988.

	Year					
	1930		1957		1988	
Habitat type	ha	%	ha	%	ha	%
Open water	3,094	47	2,638	41	2,972	45
Upland vegetation	1,364	21	1,672	26	1,589	24
Marsh vegetation	1,214	18	1,123	17	1,369	21
Tidal flat	454	7	500	8	134	2
Tidal pond	222	3	188	3	160	2
Permanent lake-slough	210	3	190	3	216	3
Reef/Shoal	34	<1	138	<1	113	<1
Tidal channel	3	<1	2	<1	2	<1
Confined disposal facility					48	<1
Semi-permanent pond 0.2–0.4 ha	74[1]		73[1]		24[a]	
Semi-permanent pond <0.2 ha	540[1]		435[1]		216[a]	

[a] Actual number of semi-permanent ponds delineated on aerial photos (these were not figured as part of total hectares or percentages).

wind and wave exposure has also created several small channels into the salt marshes used by wintering cranes. These openings are gradually becoming wider, deeper, and longer and are threatening the salt marsh areas of the Blackjack Peninsula in several ways. Tidal channels/openings provide pathways for sediment intrusion and recreationists into the marsh areas. Accumulation of sediment in the marsh could eventually modify marsh topography and water chemistry causing changes in the vegetation and invertebrate communities. These changes may modify the vegetation and food base of the marsh and limit the use of the area by wintering cranes. Increased public access through these openings represents another potential deleterious impact of the shoreline erosion. Fisherman and other recreationists use these openings to move into the marsh areas and their presence often disturbs birds.

A less obvious form of habitat loss is a direct result of the gradual widening and deepening of the GIWW channel. Prevailing southeasterly winds continually reshape and erode the north side of the navigable channel along unprotected reaches. The north side of the navigable channel is eroded by constant wind and wave action along unprotected reaches and the resulting changes in channel depth and morphology may render these areas of little use to wintering cranes. Project plans specify that the navigable channel be maintained at a depth of 3.6 m with a bottom width of 38 m. Project dimensions call for a side slope of 3:1 but continual wind and wave action are constantly widening the channel, especially along unprotected reaches. Stehn (1988), in a reconnaissance level study of the channel erosion, reported that channel top width now averages 128 m within the confines of the refuge and has increased to 160 m in some places. Unfortunately, accurate, up-to-date bathymetry data for the open water areas immediately adjacent to the GIWW is not currently available.

The current loss of wintering habitat at Aransas can probably be attributed to a combination of both artificial and natural factors. Artificial factors include wakes generated by commercial traffic using the GIWW and the disposition of dredged material removed from the navigable channel during routine, scheduled maintenance. Natural factors include constant wind and wave exposure (fetch) and the gradual, natural realignment of the GIWW channel. However, the exact cause and extent of the erosion and subsequent loss of crane habitat presently remains unclear.

The long-term implication of these changes in areal coverage of marsh vegetation, tidal flats, and tidal ponds is currently not clear. Whether these changes are significant in perpetuating wintering habitat at Aransas can only be determined through future studies. History suggests that the area and the affected habitat types are important to wintering cranes but the attributes which make the area attractive to wintering cranes are not known. Further detailed studies of whooping crane ecology on the wintering grounds will be necessary before inferences can be made about how such changes in habitat will affect crane use and behavior in the future.

The Corps is restricted in its ability to dispose of material removed during dredging since the area immediately adjacent to the channel has been classified as wetlands and the past practice of unconfined disposal of dredged material is now prohibited. Costs associated with transporting dredge material to areas for inland disposal are high and determining suitable locations for the inland disposal is now difficult if not impossible. Habitat creation and the construction of erosion control structures using uncontamined dredged material may be one solution to this complicated issue.

The construction of whooping crane habitat and erosion control structures using dredged material would not only serve the long-term needs of both the Corps and the USFWS, but would also avoid the more costly erosion control alternatives (i.e, realignment, rip-rap, articulated mats, etc.) currently used to protect coastal systems. The use of dredged material may represent a feasible, cost-effective alternative for long-term erosion control at Aransas. A plan which provides for both the disposal of dredged material and the construction of additional crane habitat will benefit both the Corps and the USFWS. Material removed from the GIWW during regular channel maintenance operations could be dedicated to habitat construction and used to gradually increase the amount of winter crane habitat.

The most difficult obstacle to overcome is the construction of wintering habitat using dredged material. Little information exists on what constitutes or defines preferred winter whooping crane habitat. Consequently, initial design plans would have to be based on local expertise and professional judgment. Additional studies need to be conducted at Aransas to describe the physical and structural characteristics of areas considered to be good wintering habitat so that biologists and engineers can develop a model for future habitat construction activities.

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