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C. Lee Sherrod
U.S. Army Corps of Engineers

Richard Medina
U.S. Army Corps of Engineers

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[1]C. LEE SHERROD and RICHARD MEDINA, *U.S. Army Corps of Engineers, Galveston District P. O. Box 1229, Galveston, Texas 77553*

Abstract: Aquatic, wetland, and upland habitat changes were quantified within the approximate critical habitat of the endangered whooping crane (*Grus americana*) along the Gulf Intracoastal Waterway (GIWW) through Aransas National Wildlife Refuge and San Antonio, Bay, Texas. Study procedures employed comparative analysis of pre-GIWW (1930) and present (1986) aerial photography to provide a basis for the assessment of positive and negative impacts of the construction, operation and maintenance of the GIWW, principally on the whooping crane, but also on biota in general. Thirteen habitat mapping categories were utilized to describe an approximately 1,830 m wide corridor along the GIWW from Blackberry Island near Port O'Connor southwestward to Dunham Island, south of the Aransas National Wildlife Refuge. An 11% loss of whooping crane habitat has occurred from 1941 to 1986 due to construction, operation and maintenance of the GIWW and Victoria Channel.

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Preliminary estimates of habitat alteration by the U.S. Fish and Wildlife Service (Stehn 1986) have raised concerns regarding the potential negative impact of the future operations and maintenance of the Gulf Intracoastal Waterway on wintering habitat of the endangered whooping crane in the Aransas National Wildlife Refuge (ANWR) and adjacent San Antonio Bay, Texas (Fig. 1). The principal concerns relate to the possible losses or alterations of prime winter feeding habitat (shallow water shorelines and low tidal marshes) as a result of channel erosion and maintenance dredging material disposal.

To better plan and evaluate possible operational and maintenance alternatives for the GIWW over the next 50-year period, it was necessary to determine the positive and negative effects that have occurred since initial construction of the channel in 1941.

The GIWW was initially designed and constructed prior to the advent of significant environmental concerns and regulations. The primary design objectives were navigational safety and efficiency, and minimization of dredging costs. Thus in most instances the channel was located in nearshore shallow waters within the bays to provide ease of access to port facilities. However, the channel was generally not placed in upland areas in order to avoid excessive dredging. Dredged material was typically placed on the bayward side of the channel to provide a barrier against storms and prevailing winds. The majority of impacts which have occurred to the adjacent wetland and shallow-water habitats have largely been a result of these early design considerations.

This study was conducted in an attempt to ascertain the initial dredging impact of the GIWW and to determine the cumulative effects of dredged material disposal and channel erosion since initial construction in 1941. Also included in this study was an approximate 3.2-km length of the Victoria Channel (Fig. 1), which was initially constructed in 1960 and is also within the critical habitat range of the whooping crane.

METHODS

A study corridor 1,830 m (915 m on either side of the channel) wide was determined to be the minimum width that would include all perceptible

[1]*Present Address: Horizon Environmental Services, Inc., P. O. Box 162017, Austin, Texas 78716*

GIWW-related alterations. The corridor extended approximately 58 km along the GIWW within the critical habitat range of the whooping crane, with the exception of San Antonio Bay proper, from Blackberry Island near Port O'Connor southwestward to Dunham Island, south of the ANWR. Pre-GIWW aerial photography or land classification mapping of the open water portion of San Antonio Bay along the GIWW was not available and precluded inclusion of that section in the analysis. An additional 3.2-km length of the Victoria Channel along the northeastern edge of San Antonio Bay was included. A study corridor width of approximately 305 m on either side of that channel was determined to be the minimum width that would include all pereeptable channel-related alterations.

Habitat mapping along the GIWW was accomplished on 1930 black and white and 1986 true-color aerial photography at scales of 1":1500' and 1":1000', respectively. Habitat types delineated included deep water (generally deeper than 1 m); shallow water (less than 1 m); reefs; submerged vegetation (seagrasses); low marsh; high marsh; unvegetated tidal flat; tidal pond; land-locked pond, lake or marsh; upland grassland; upland brush; upland woodland; and disturbed (predominantly recent dredging material disposal).

Initial habitat mapping was accomplished on the 1986 color photography. A limited field reconnaissance was then conducted from 2-4 March 1987, largely by boat from the GIWW and accessible areas to verify photo imagery and to characterize habitats. Final mapping was then conducted on the color photography reflecting field changes and adjustments. Mapping on the 1930 black and white photography was accomplished by comparative analysis of imagery with the 1986 photography in areas not affected by the GIWW. Assistance in all photo interpretation was provided by partial coverage of color infrared photography, nautical charts and USGS quad sheets. While some areas of recent alteration not evident on the 1986 photography were observed during the field reconnaissance, only the habitats as evidenced by the 1986 photography were considered in the analysis for consistency.

Respective habitat maps were digitized on an AUTOCAD computerized mapping system and equalized to scale for reproduction. Acreages of habitat types were determined by computer digitization. A comparative overlay of the 1930 and 1986 maps indicating positive and negative changes in crane habitat was produced.

The areal extent of the various habitats was determined by digital planimetry of the 1930 and 1986 maps. Overall changes in areal extent of the various habitat types since construction of the channel were then determined. Estimates of the direct impacts of the original channel construction for dredging only were determined by approximating the location of the channel on the 1930 map and planimetering habitat areas within a 64 m wide corridor which would have been the average original top width with a designed 38 m bottom width at 4.3 m in depth with 3:1 side slopes. Approximations of obvious direct losses and gains of whooping crane habitats were made by superimposing existing channel dimensions and readily apparent dredged material disposal areas from the 1986 imagery over the 1930 habitat map and planimetering areas of positive and negative change.

DESCRIPTION OF HABITAT TYPES

The accuracy of mapping was generally limited by the quality and scale of the 1930 black and white photography. A minimum mapping standard of about 0.4 ha was generally established on the black and white imagery and carried through to the 1986 color photography to maintain consistency of mapping units to the greatest extent possible. As a result, areas of other habitats too small for accurate delineation were not segregated from the mapped types.

The various habitat types were described according to relative elevation and vegetation composition. Relative species abundance may vary within a habitat type, but the type generally has the same overall vegetative characteristics and habitat function.

Deep Water

Deep-water habitats were open bay waters generally deeper than 1 m.

Shallow Water

Shallow-water habitats were areas of open water generally between mean water level to 1 m deep. Shallow-water habitats frequently occurred along edges of dredged channels and the dredged material disposal areas. Shallow-water habitats included areas of reefs or submerged vegetation which were either too small for accurate delineation or were too sparse to provide a sufficiently distinct image on the photography.

Reefs

Reefs observed within the project area were composed of either oyster or clam shell accumulations, often partially exposed during low tides.

Submerqed Vegetation

Submerged vegetation consisted of a mixture of shoalgrass (*Halodule wrightii*) and widgeongrass (*Ruppia maritima*) occurring in shallow-water habitats usually between 0.3 and 1 m deep. Substrates of the shallow water habitats were soft to moderately firm and consisted of sand and silt.

Low Marsh

Low marshes occurred in low-lying areas which generally received frequent inundation by tides. The primary distinction between low marsh and high marsh was the apparent elevation and frequency of inundation by tides as evidenced in the field by the relative abundance of tidally-deposited debris present within the marsh areas. Delineation of the 2 types from the aerial photography was based on perceptible differences in color tone, texture and vegetative cover. The low marshes tended to a have a darker color indicating a higher degree of saturation and a more homogeneous vegetative cover. Another striking characteristic of the low marsh was the presence of numerous tide ponds and channels. Most of the tide ponds and channels were too small for individual delineation. In some instances, these small ponds and channels constituted as much as 40-50% of the mapped low marsh habitat. Two types of low marsh were observed in the area; low marshes dominated by smooth cordgrass (*Spartina alterniflora*) and low marshes dominated by saltwort (*Batis maritima*) and sea oxeye daisy (*Borrichia frutescens*).

Hiqh Marsh

High marshes typically occurred in areas which were occasionally flooded by rainfall or higher tides. Vegetative cover varied from densely vegetated areas to open sandy areas with sparse or scattered vegetation. The dense areas were generally dominated by species such as shore grass (*Monanthochloe littoralis*), salt grass (*Distichlis spicata*), sumpweed (*Iva* sp.) and/or *Borrichia frutescens*. Other species were usually mixed in these areas at varying densities. The sparse areas of the high marsh were generally vegetated with scattered clumps of saltwort (*Salicornia biqelovii and S. virqinica*), sea lavender (*Limonium nashii*), Carolina wolfberry (*Lycium carolinianum*) and sea blight (*Sueada linearis*). Sparse high marsh was separated from sparsely vegetated tidal flat by having greater than 25% vegetative cover as determined by ocular estimation. In areas where the high marsh graded upwards into upland grassland, grass species such as gulf cordgrass (*Spartina spartinae*), marshhay cordgrass (*Spartina patens*), and seacoast bluestem (*Schizachyrium scoparium*), were mixed along this ecotone.

Tidal Flat

Tidal flats typically occurred as flat, barren washover areas which were influenced by tidal regimes and wind. Topographically, tide flats occurred from about mean water level up to 0.5 or 1 m in elevation. Because of the cyclic pattern of inundation and drying, tidal flats usually have hyper-saline sediments which generally support only algae or occasional sparse patches of *Salicornia biqelovii, S. virqinica, Monanthochloe littoralis, Suaeda linearis and Batis maritima*. Vegetative cover, however, is less than 25%. The lower portions of tidal flats were often covered with a dense layer or crust of algae which gave the soil surface a dark appearance.

Tidal Ponds

Tidal ponds were confined primarily to the low marsh areas. Tide ponds were distinguished from shallow water by being mostly enclosed within the low marsh zone and were distinguished from the land-locked ponds by having an observable or probable tidal connection due to their location in the frequently inundated low marsh. Vegetation occurring along the edges of tidal ponds consisted primarily of those species common to the low marsh (e.g. *Spartina alterniflora, Scirpus* sp., *Batis maritima* and *Borrichia frutescens*). Common reed (*Phragmites communis*) was also observed along the edges of a few tidal ponds.

Upland Grassland

Upland grasslands were frequently dominated by Spartina spartinae and were topographically higher than the marsh areas. These grasslands would not typically be affected by tidal regimes except during extreme storm events. Other herbaceous species commonly found in the grasslands included *Spartina patens*, *Schizachyrium scoparium*, *Dicanthelium* sp., prickly pear (*Opuntia* sp.) and *Monanthochloe littoralis* in the lower areas of the grasslands. Scattered mesquite (*Prosopis* sp.) and seamyrtle (*Baccharis halimifolia*) also occurred in the upland grasslands.

Land-Locked Ponds, Lakes or Marshes

Land-locked ponds and lakes were typically depressions within the upland grasslands, but also included ponded water inside dredge disposal levees, generally not affected by tides. Over time, fresh-water marshes have developed along the perimeters or within some of these freshwater ponds and lakes. Typical freshwater species included rushes (*Juncus* spp.), bullrushes (*Scirpus* spp.), spike rushes (*Eleocharis* spp.) cattails (*Typha* spp.), sedges (*Carex* spp. and *Cyperus* spp.) and *Phraqmites communis.*

Upland Brush

Upland brush occurred primarily on the higher portions of the dredge material disposal areas. Between Port O'Connor and San Antonio Bay, brush species were composed of *Baccharis halimifolia*, *Prosopis* sp. and prickly ash (*Zanthoxylum* sp.). The understory was composed of various grasses from the upland grasslands and *Opuntia* sp.

The dredged material islands across from the Aransas National Wildlife Refuge contained upland brushlands which were much denser than those found in other areas. Brush species were generally the same with the addition of several *Acacia* species. Understory species included saplings of the overstory, various grasses from the grasslands, *Opuntia* sp. and *Yucca* sp.

Upland Woodlands

Upland woodlands were composed of an overstory dominated primarily by live oak (*Quercus virginiana*). Other common species typically included *Prosopis* sp. and hackberry (*Celtis* sp.). Upland woodlands occurred typically as dense mottes or thickets. Canopy coverage was usually between 75 to 100%.

Disturbed

This category was generally applied to areas of recent vegetation removal or burial, primarily new dredging material disposal areas and levees.

RESULTS

Habitat changes occurring between 1930 and 1986 are presented in Table 1. The mapping effort for the entire study area was too voluminous to be presented in its entirety here, but representative examples showing the Victoria Channel are provided in Figs. 2 and 3. While it can be assumed that the majority of changes have been the direct or indirect result of the construction, operation and maintenance of the GIWW, some changes are attributable to other processes such as natural erosion and accretion, subsidence, reef building or decline, natural marsh evolution and succession, fire, influence of cattle grazing and range management and other human activities. It was not possible within this limited analysis to distinguish specifically between GIWW caused changes and changes attributable to other processes.

The areal extents for direct impacts associated with original dredging are presented in Table 2. Table 3 presents approximations of obvious direct losses and gains of suitable whooping crane habitats (see Fig. 4 for the same mapping segment as in Figs. 2 and 3).

The greatest overall changes, in terms of areal coverage, occurred in the deep water, shallow water, submerged vegetation and upland grassland habitats (Table 1). Both deep water and upland grassland increased significantly as a result of channel dredging and dredged material disposal. Shallow water and submerged vegetation decreased substantially while tidal flats, tidal ponds and high marsh decreased to a smaller extent. Low marsh remained nearly equal while slight to moderate increases were noted for reefs, land-locked ponds or marshes, upland brush and upland woodlands. The presence of disturbed habitat (new dredged material disposal) in 1986 most likely resulted in loss of upland grassland or upland brush within the old contained disposal cells and would be expected to return to those habitats over time.

The majority of impacts as a result of the original dredging of the GIWW and Victoria channels occurred to shallow water and low-fringe habitats (Table 2). The alignment of the GIWW was more or less intended to skirt the edge of the bay margins, thus the resulting high impacts to shallow water, low marsh and tidal flat habitats.

In the analysis of losses and gains of crane habitat as a result of channel construction, operation and maintenance, concepts of crane habitat value and alteration as expressed by Stehn (1986) were followed. Habitats which were considered favorable for whooping cranes included shallow water, submerged vegetation, low marsh, high marsh, tidal flat and tidal ponds. While it is understood that these categories vary in their respective value and usage as crane supporting habitats, they were all treated as equal for the purpose of this analysis. Shallow water and submerged vegetation habitats are not often directly utilized by cranes except along immediate shorelines, but these habitats support the food organisms of cranes and are, therefore, considered beneficial. However, as part of this analysis, instances of conversion of shallow water and submerged vegetation habitats to low marsh, high marsh, tidal flat or tidal pond were considered a positive gain of crane habitat which would be more readily useable by cranes. Loss of habitat was considered as alteration of shallow water or tidal wetland habitats to deep water (channel) or upland habitats (dredged material disposal). No analysis was made of changes of habitat types within the general categories (i.e. tidal flat to low marsh or upland grass to upland brush).

Table 3 presents losses and gains of crane habitat by habitat type. Totals of losses and gains are also provided for study area sections of the GIWW as described in Table 1. Areal extents for habitat changes were determined by electronic digital planimetry of area differences between the 1986 map and the 1930 map (Fig. 4). The dimensions for the deep water of the channel were photo-interpreted from the 1986 color photography. Those dimensions include original channel dredging width and any subsequent widening or erosion that may have occurred.

For the 3 major study area sections, the gross loss to gain ratio of suitable crane habitats (including original channel dredging impacts) was nearly equal with Section A (Blackberry Island to San Antonio Bay) having a 2.7:1 ratio, Section B (False Live Oak Point to Dunham Island - ANWR) a 2.9:1 ratio, and Section C (Victoria Channel) a 2.6:1 ratio.

Impact totals for the original channel dredgings were separated from the gross totals and habitat loss and gain was computed for channel operations and maintenance (Table 3). For the GIWW, the loss to gain ratio was 2.0:1. This represents an average net loss of about 10.4 ha of crane habitat per year over the past 45-year operations and maintenance period for the GIWW. For the Victoria Channel, the loss to gain ratio was very near 1:1 or only 0.08 ha per year loss over the past 26-year period.

While the average net loss on the GIWW during the 45-year operation and maintenance period is more than 10 ha per year, these losses were probably accelerated in the first years following construction. Habitat losses over the last 10-15 years from dredged material disposal are substantially less. Since the early 1970's, dredging within the reaches of the study area has been infrequent. Most of the dredged material has been placed in upland, leveed disposal areas, thus minimizing the habitat losses during these years. Losses as a result of erosion, however, continue to exist and, based on recent ANWR data, may be accelerating.

Overall, of the approximately 7,483 ha of suitable crane habitat (SW, SV, LM, HM, TF, TP) within the study corridor in 1930 (Table 1), the net loss of 841.5 ha (original channel dredging, plus operation and maintenance minus habitat gains) as of 1986 (Table 3) represents a net 11% loss.

Additional studies and strategy planning are presently underway to determine the possible effects of future channel operation and maintenance on the whooping crane. Formulation of dredged material disposal and management plans which will minimize or eliminate further losses of suitable crane habitat and methods of habitat enhancement and creation are also being explored.

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LITERATURE CITED

Stehn, T. 1986. Impacts of the Gulf Intracoastal Waterway on the endangered whooping crane. U.S. Fish & Wild. Serv., Aransas NWR, Tex.

Table 1. Summary of habitat changes, Aransas NWR, Texas, 1930-1986.

	Section A (Blackberry Island to San Antonio Bay) Areal Extent				Section B (False Live Oak Point) to Dunham Island) Areal Extent				Section C (Victoria Channel) Areal Extent				Total Areal Extent			
	(Hectares)		Change		(Hectares)		Change		(Hectares)		Change		(Hectares)		Change	
Habitat Type	1930	1986	Ha	%	1930	1986	Ha	%	1930	1986	Ha	%	1930	1986	Ha	%
Deep Water	312	534	+222	+71	705	869	+164	+23	181	221	+40	+22	1198	1624	+426	+36
Shallow Water	857	539	-318	-37	1684	1483	-201	-12	385	292	-93	-24	2926	2314	-612	-21
Reef	6	32	+26	+433	56	68	+12	+21	2	3	+1	+50	64	103	+39	+61
Submerged Vegetation	1200	892	-312	-26	270	224	-46	-17	26	73	+47	+181	1496	1189	-307	-21
Low Marsh	599	538	-61	-10	789	858	+69	+9	105	103	-2	-2	1493	1499	+6	+0.4
High Marsh	346	325	-21	-6	348	212	-136	-39	67	62	-5	-7	761	599	-162	-21
Tidal Flat	327	282	-45	-14	83	54	-29	-35	8	17	+9	+113	418	353	-65	-16
Tidal Pond	79	111	+32	+40	277	185	-92	-33	33	36	+3	+9	389	332	-57	-15
Land-locked, P.L.M.	47	66	+19	+40	3	—	-3	-100	—	—	—	—	50	66	+16	+32
Upland Grassland	881	1248	+367	+42	57	130	+73	+128	104	103	-1	-1	1042	1481	+439	+42
Upland Brush	2	79	+77	+3850	18	49	+31	+172	1	2	+1	+100	21	130	+109	+519
Upland Woodland	—	5	+5	NA	15	22	+7	+47	—	—	—	—	15	27	+12	+80
Disturbed	—	5	+5	NA	—	151	+151	NA	—	—	—	—	—	156	+156	NA
TOTAL	4656	4656			4305	4305			912	912			9873	9873		

Table 2. Approximate extent of impacts from the original GIWW and Victoria Channel dredgings.[1]

Habitat Type	GIWW Impacts (Hectares)	Victoria Channel Impacts (Hectares)
Deep Water	24.6	0.4
Shallow Water	103.0	20.2
Submerged Vegetation	35.0	0.6
Low Marsh	83.0	1.6
High Marsh	31.9	3.8
Tidal Flat	75.8	—
Tidal Pond	8.3	—
Upland Grassland	0.8	2.5
Upland Brush	0.3	—
Reef	—	0.3
TOTAL	362.7	29.4
TOTAL SHALLOW WATER AND WETLANDS	337.0	26.2

[1] Areas are for channel width only and do not include adjacent dredged material disposal. GIWW original average top width is assumed at 85 meters.

Table 3. Approximate extent of loss and gain of whooping crane habitats, 1930-1986.

Channel Section[1]	1930 Habitat Type[2]	Altered To (Hectares) (1986) Channel (Deep Water)[3]	Upland Habitats[4]	Wetland Habitats[5]
GIWW	SW, DW, SV	NA	NA	264.8
Section A	SW	62.5	70.8	
	SV	46.2	300.8	
	LM	51.7	39.4	
	HM	24.0	0.5	
	TF	71.7	29.3	
	TP	1.0	9.1	
	R	0.9	—	
	TOTAL	258.0	449.9	264.8
GIWW	SW, DW, SV	NA	NA	180.8
Section B	SW	117.9	96.2	
	SV	7.0	8.7	
	LM	55.9	113.3	
	HM	26.0	69.5	
	TF	13.8	8.5	
	TP	18.0	16.0	
	TOTAL	238.6	312.1	180.8
Victoria Channel	SW, DW, SV	NA	NA	17.5
Section C	SW	30.5	5.9	
	SV	1.9	—	
	LM	2.2	0.7	
	HM	4.4	0.4	
	TOTAL	39.0	7.0	17.5
TOTALS				
GIWW				
	Section A	258.0	449.9	264.8
	Section B	238.6	312.1	180.8
	Gross Total	496.6	762.0	445.6
	Minus Original Dredging (Table 2)	- 337.0		
	Total Operations and Maintenance	159.6	762.0	445.6

Table 3 (concluded)

Channel Section[1]	1930 Habitat Type[2]	Altered To (Hectares) (1986) Channel 3 (Deep Water)[3]	Upland Habitats[4]	Wetland Habitats[5]
Victoria Channel				
	Gross Total	39.0	7.0	17.5
	Minus Original Dredging (Table 2)	- 26.2		
	Total Operations and Maintenance	12.8	7.0	17.5
All Sections				
	Gross Total	535.6	769.0	463.1
	Minus Original Dredging (Table 2)	- 363.2		
	Total Operations and Maintenance	172.4	769.0	463.1

[1]Channel corridor sections as defined in Table 1.

[2]SW - shallow water, SV - submerged vegetation, LM - low marsh, HM - high marsh, TP - tidal pool, TF - tidal flat, R - reef. DW (deep water), SW and SV areas converted to wetland habitats were considered to be a positive gain of crane habitat.

[3]Channel dimensions are those delineated as deep water on the 1986 aerial photography which includes original dredging width and any erosion which has since occurred.

[4]Includes upland grassland, upland brush, and upland woodland where these habitats have obviously been created by dredged material disposal.

[5]Includes low marsh, high marsh, tidal flat, and tidal pond which are assumed to be Whooping Crane habitats.

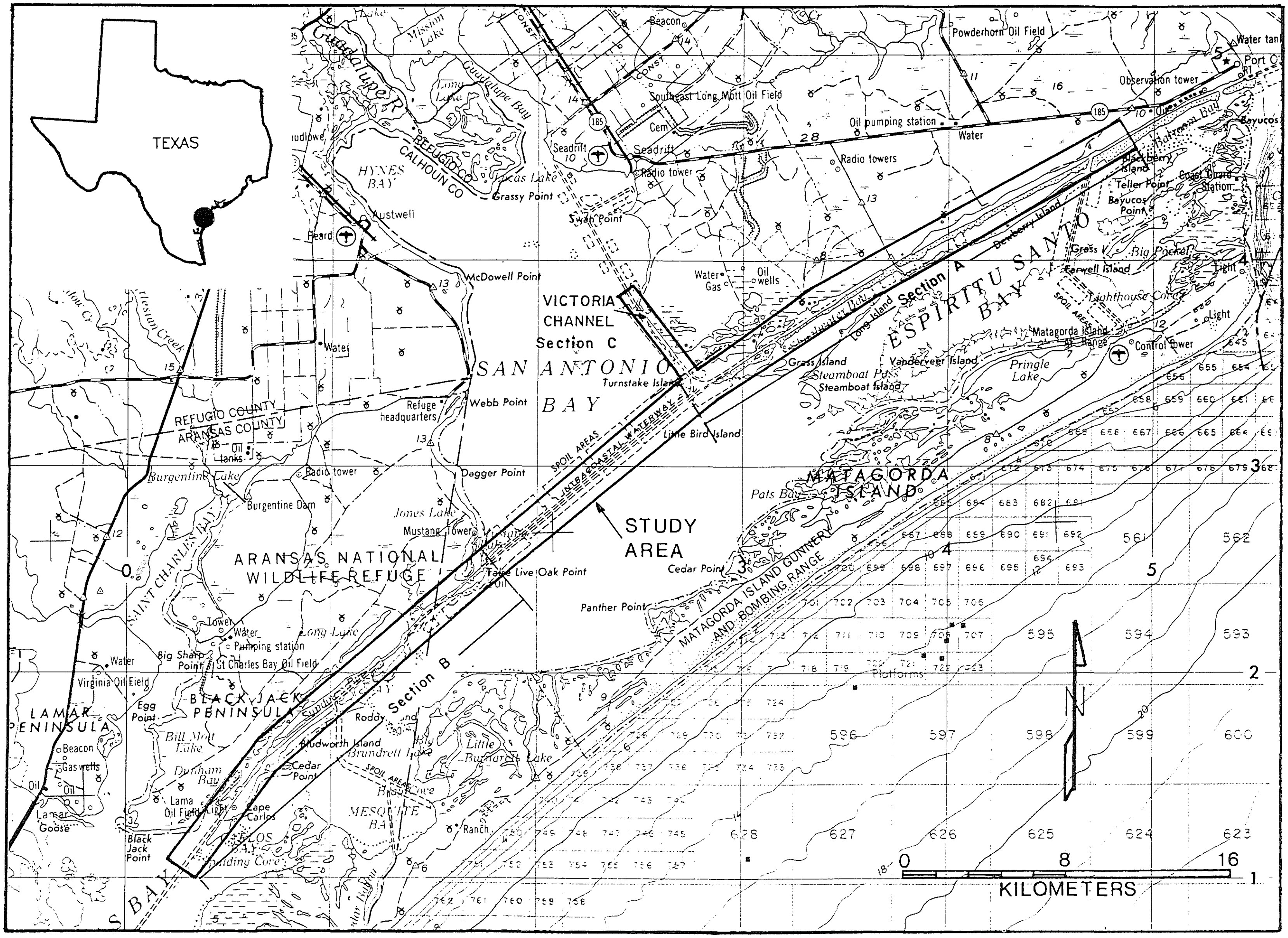

Figure 1. Study area location.

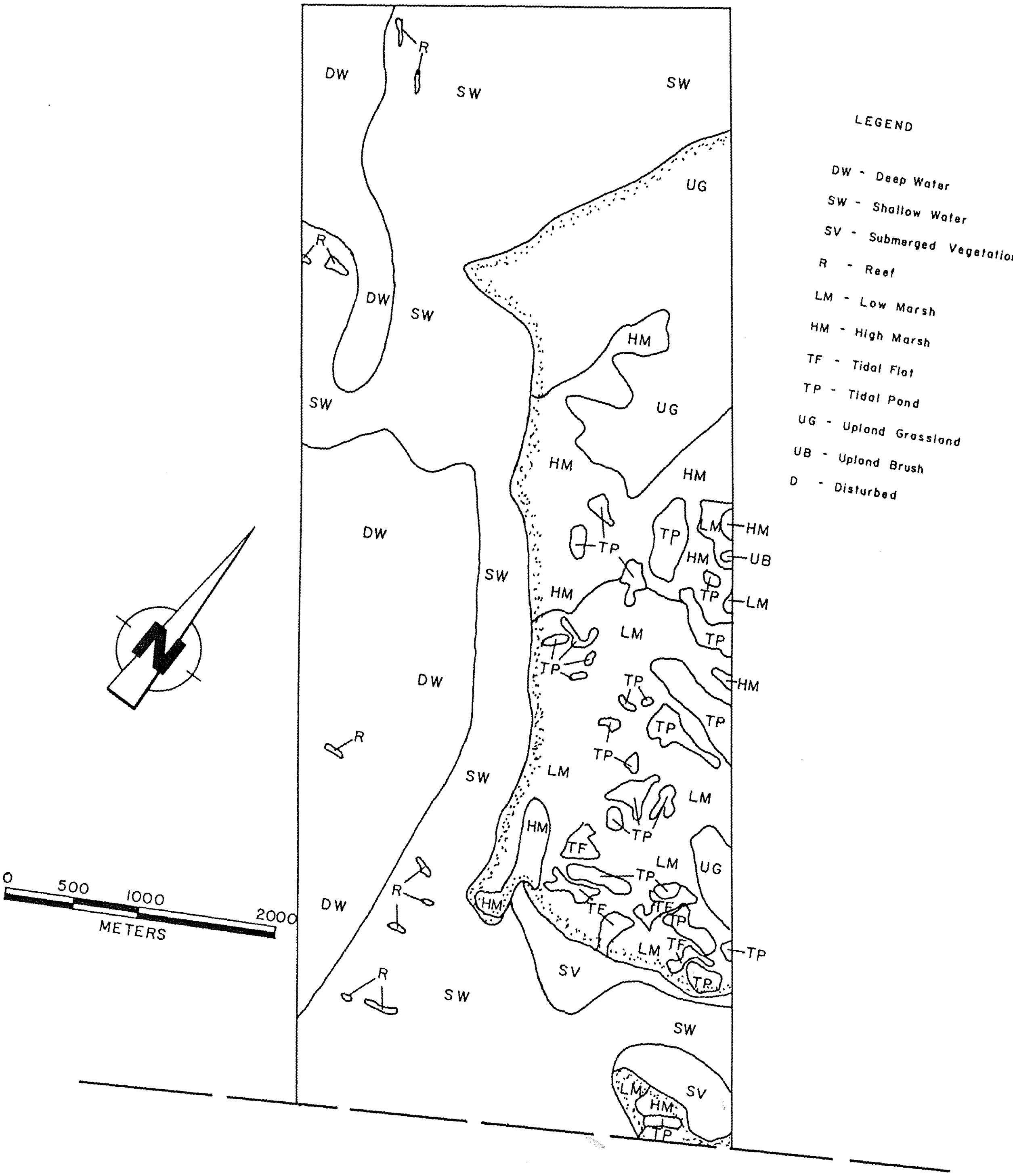

Figure 2. Pre-channel habitat depiction as delineated from 1930 black and white aerial photography.

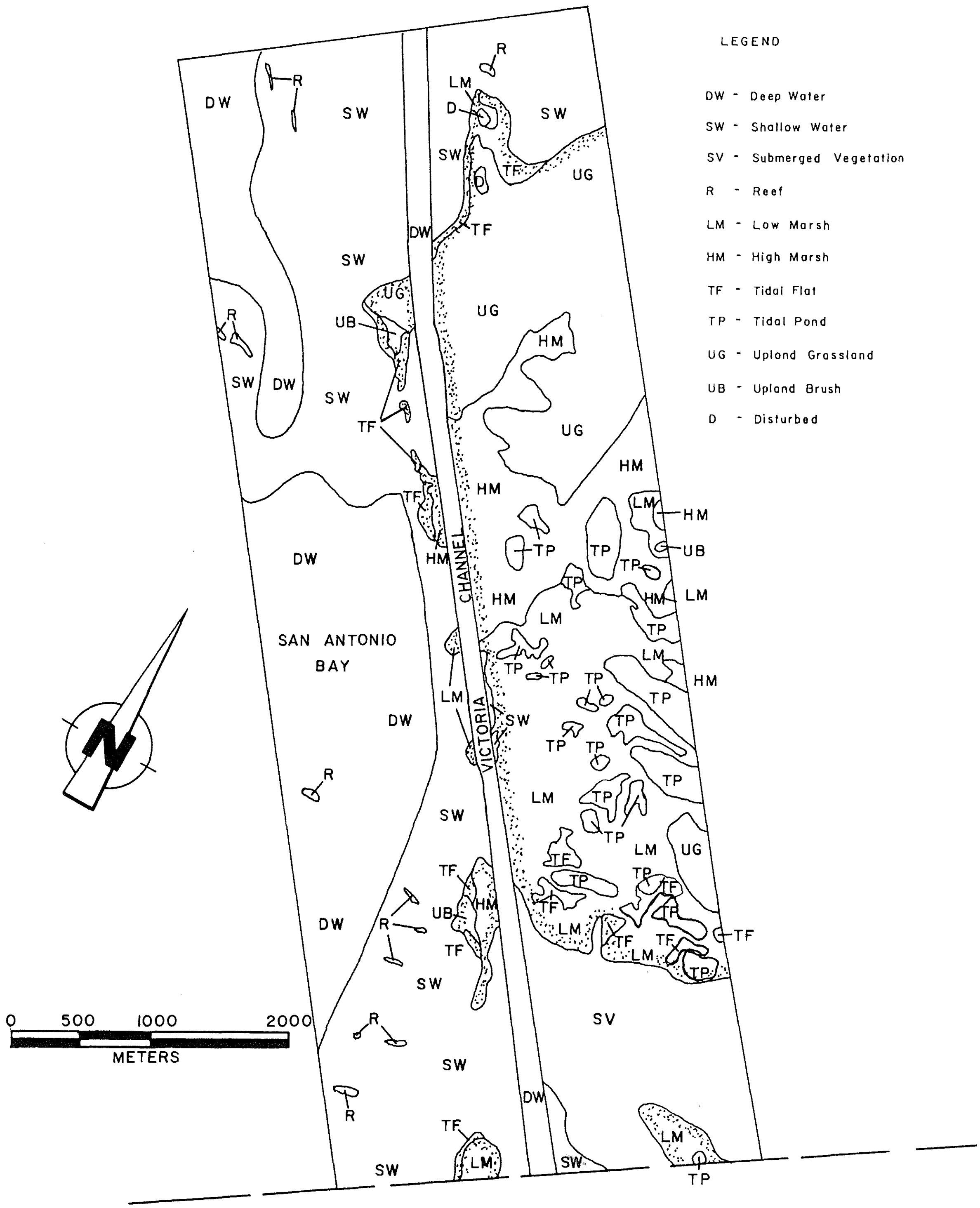

Figure 3. Habitat depiction as delineated from 1986 color infrared aerial photography.

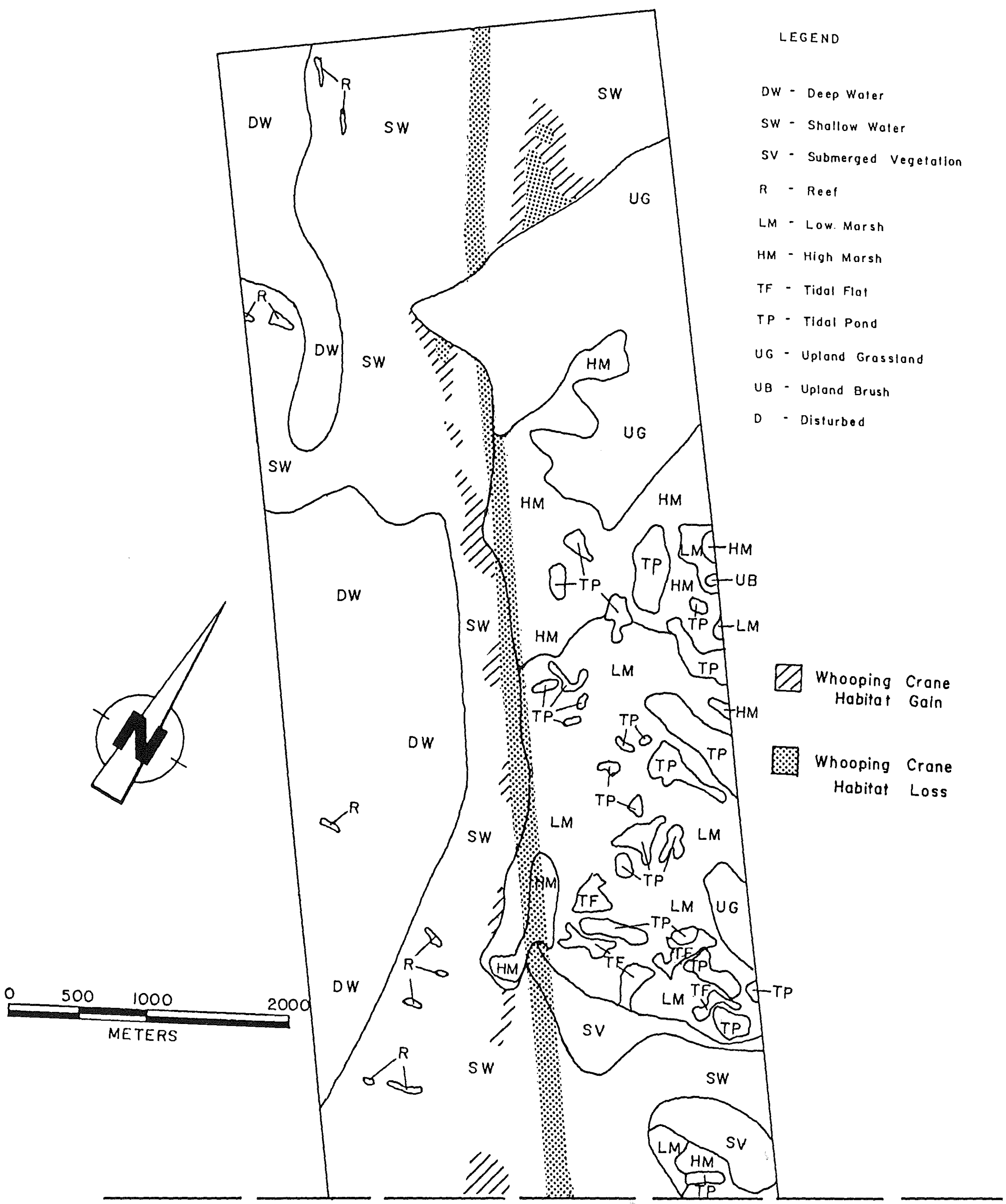

Figure 4. Depiction of whooping crane habitat loss and gain.