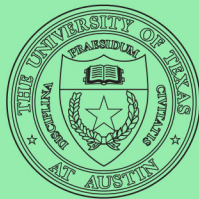


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EVALUATING THE ENVIRONMENTAL GEOLOGY MAP, ENVIRONMENTAL GEOLOGIC ATLAS OF THE TEXAS COASTAL ZONE

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ABSTRACT

Comparison of Environmental Geology maps, from the Environmental Geologic Atlas of the Texas Coastal Zone, with aerial photographs taken in February 1975 revealed changes related to economic development of the region and to ongoing natural processes. The areal extent of these changes, however, amounts to only 0.9 percent of the 11,820 square miles (30,610 km²) covered by the 1975 photographs. Nearly half of the 1,105 changes detected involved channel dredging, spoil disposal, reworking of existing spoil, and creation of made land. The greatest number of natural changes involving a single environmental geologic unit resulted from dune migration in Kenedy County. The changes detected do not detract from the Environmental Geologic Atlas of the Texas Coastal Zone as a thorough, detailed, but open-ended compilation of resource information.

INTRODUCTION

A recently completed analysis of Landsat satellite imagery of the Texas coastal region (Finley, in preparation) focused on the discrimination of land cover and land use through the development of a classification system and mapping techniques, and the examination of test sites. Maps from the seven volumes of the Environmental Geologic Atlas of the

Texas Coastal Zone (Brown, coordinator, in progress) (fig. 1) aided in the interpretation of Landsat imagery. The 1:125,000 scale Environmental Geology map provided information on substrate materials, geologic processes, biologic materials, and man-made units. Special derivative maps, Current Land Use, and Environments and Biologic Assemblages, provided invaluable data for initial image interpretation and for formulation of appropriate land cover and land use categories. The Environmental Geology map was also used to control enlargement of the 1:1,000,000 scale Landsat imagery to a mapping scale of 1:125,000 (Finley, 1976) and, during the final phase of the investigation, to evaluate the accuracy of the test site mapping.

To indicate whether the Coastal Atlas maps (based on 1956-59 Edgar Tobin aerial photomosaics at a scale of 1:24,000) reflected current conditions, part of each Environmental Geology map was compared to aerial photographs obtained in February 1975. These photographs, both color and color-infrared, were taken by the National Aeronautics and Space Administration (Mission 300, 1:120,000 scale) to assist in the development of Landsat imagery as a tool for the monitoring of Texas coastal resources. The area covered by the photographs approximately corresponds to the seaward half of each Environmental Geology sheet, a coast-parallel strip some 20 to 25 miles (32.2 to 40.2 km) wide. Changes in environmental geologic units were compiled on a transparent overlay at a scale of 1:125,000 from these photographs.

The areal extent of the changes on each Environmental Geology map varied from 0.19 percent of 1,590 square miles ($4,118 \text{ km}^2$) examined on the Brownsville - Harlingen Sheet to 2.1 percent of 1,450 square miles

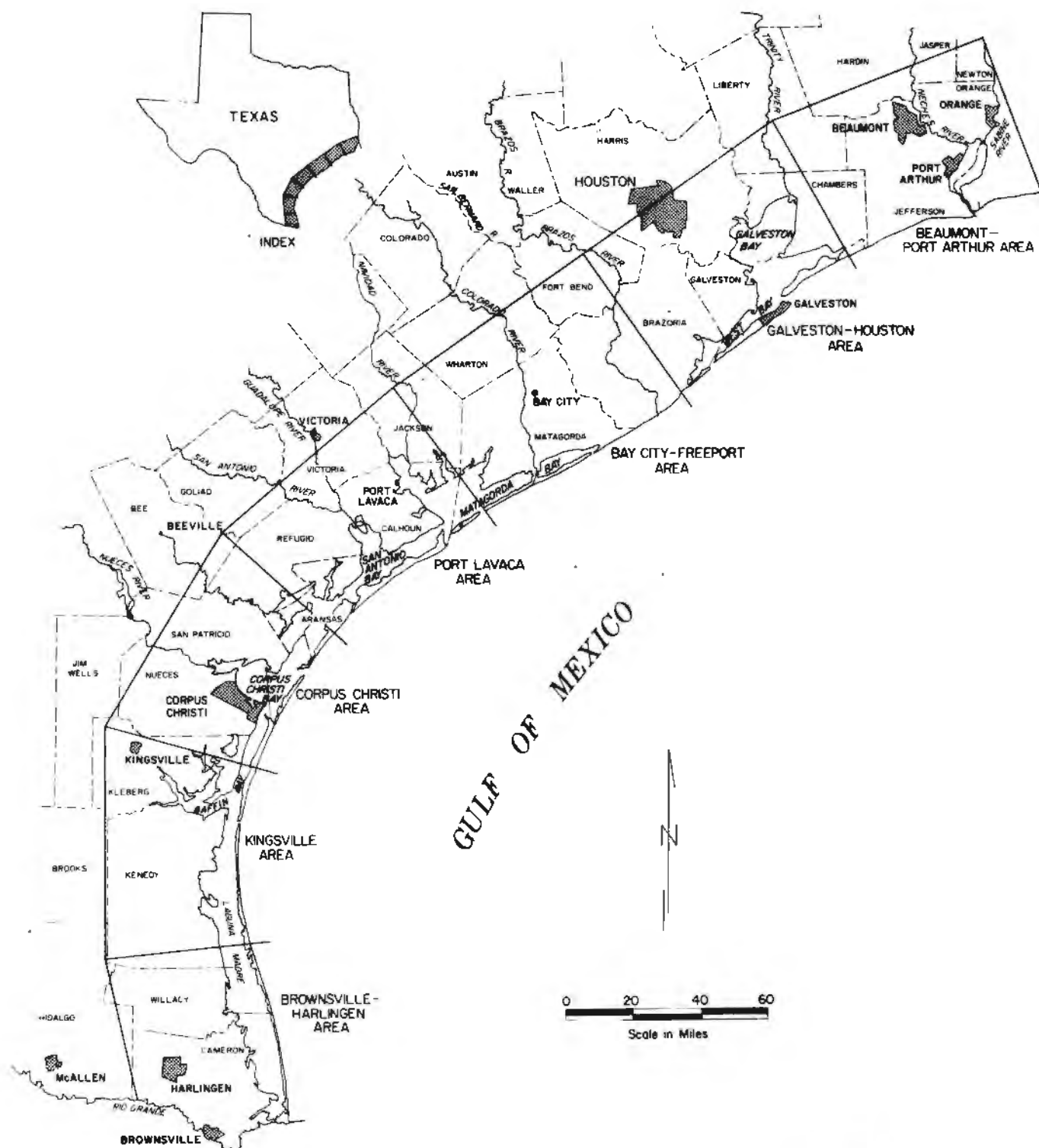


Figure 1. Index of the Environmental Geologic Atlas of the Texas Coastal Zone.

(3,756 km²) examined on the Beaumont - Port Arthur Sheet. The average total change area for that part of each sheet examined was a relatively insignificant 0.94 percent across all seven folios of the Coastal Atlas.

MAPPING PROCEDURES

Differences between the Coastal Atlas maps and the aerial photographs were classified as either additions or deletions. Additions refer to boundary expansion of an existing area within the same category or to delineation and classification of a new area. Deletion refers to contraction of an existing classified area. Most of the changes were considered additions. For example, the emplacement of new dredge spoil was noted as addition of dredge spoil rather than as deletion of the bay-bottom environment.

The updated overlays are intended to be used with the Environmental Geology maps from the Environmental Geologic Atlas of the Texas Coastal Zone (Brown, coordinator, in progress). A complete set of overlays are available at the Bureau of Economic Geology in open-file format for use by all interested persons and State agencies. The overlay line boundaries were derived from the same negatives as the original map (fig. 2). Categories in the explanation of the Coastal Atlas map were numbered, making it easy to correlate all changes with the appropriate new category on the overlay. Proper registration of the map and overlay makes possible the comparison of the original mapping and explanation with the additions and deletions derived from the more recent, color-infrared photographs.

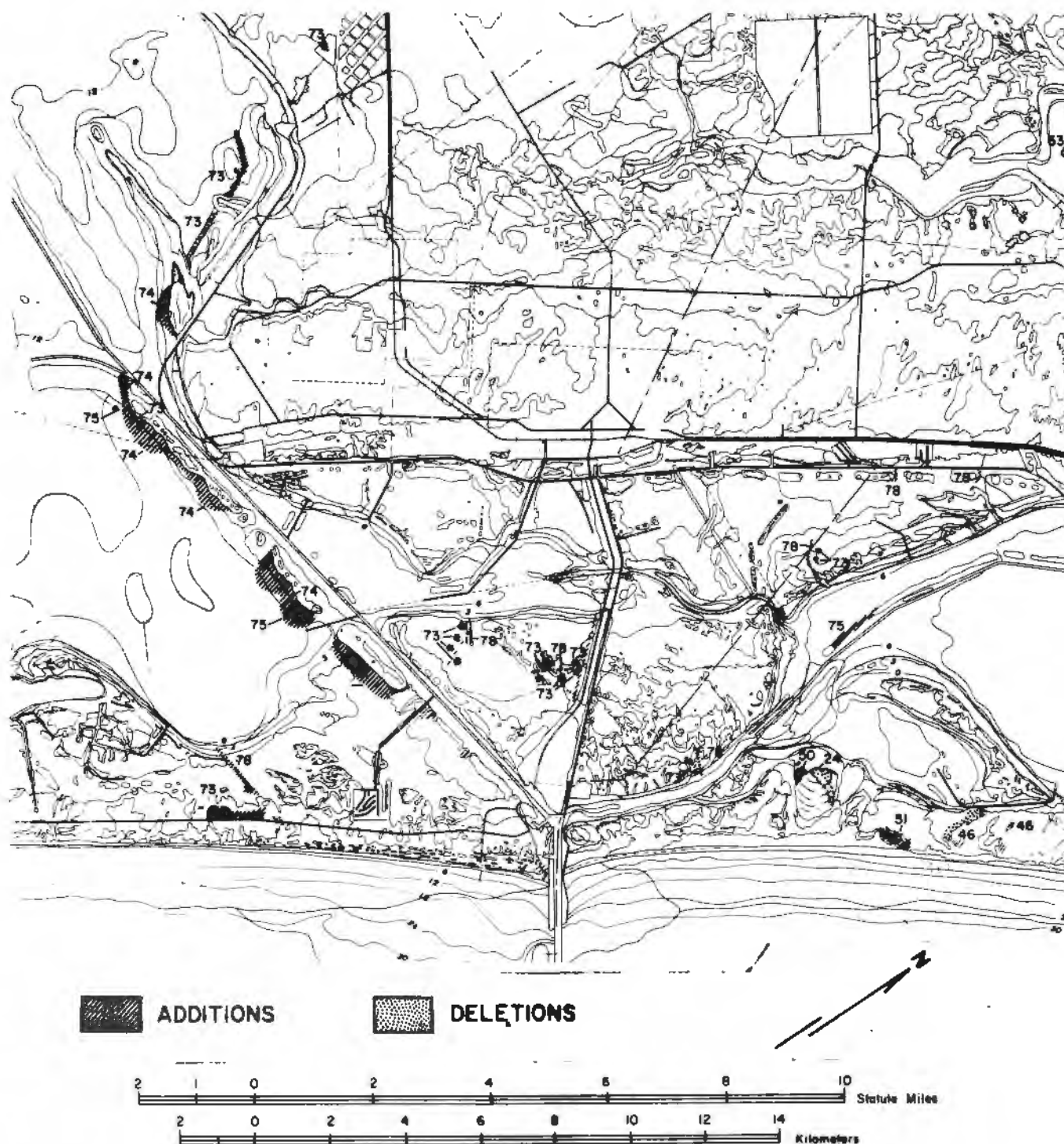


Figure 2. An example of the overlay updating the Environmental Geology map covering the Harbor Island vicinity. The following categories are indicated: 24, wind-tidal flat; 46, stabilized blowout dune complex; 50, washover distal fan; 51, fore-island blowout dunes; 63, bay and lagoon mud; 73, subaerial spoil; 74, subaerial reworked spoil; 75, subaqueous spoil; 78, dredged channel.

The objective in delineating these environmental changes was simply to supplement existing maps as a source of ground data for use in the interpretation of Landsat imagery. No attempt was made, therefore, to separate seasonal or temporary changes, such as the drying up or temporary draining of a man-made pond and its consequent invasion by vegetation, from permanent alterations of the coastal environment. Remapped units were not field checked except coincidentally within test sites analyzed in detail as part of the Landsat investigation.

ALTERATION OF COASTAL ENVIRONMENTS

When mapping for the Coastal Atlas project began in 1969, 1:24,000 scale Edgar Tobin Aerial Surveys black-and-white photomosaics provided the only uniform coverage of the entire 20,000 square mile area included in the seven coastal atlases (Brown, and others, 1976). Most of the photomosaics were composed of photographs taken between 1955 and 1959. Mapping for the Coastal Atlas required extensive interpretation of aerial photographs, field checking, low-altitude aerial reconnaissance, and utilization of published maps and reports. These data were assembled on a new map base compiled from 7.5-minute U.S. Geological Survey quadrangle maps on which updated cultural features and all paved roads were included (Brown and others, 1976). Whether the use of photomosaics nearly 20 years old detracts significantly from the overall utility of the Environmental Geologic Atlas of the Texas Coastal Zone is a question which can now, in part, be answered.

Any coastal region is highly dynamic and undergoes continuous modification by daily processes of erosion and accretion, by passage of storms, by natural biologic processes, and by presence of man. Most changes detected using the February 1975 photographs were minor revisions relating to (1) man's industrial, commercial, and residential activity, and (2) dynamic natural geologic and biologic processes characteristic of the coastal zone. Among the latter are the effects of wind, tidal and longshore currents, and the colonization of new substrate by marsh vegetation. Table 1 lists some of the specific, more frequent types of changes which were encountered. These alterations are of the type which certainly would be expected in a coastal environment bearing 34 percent of the economic resources of the State of Texas. The changes detected in no way detract from the Environmental Geologic Atlas as a thorough coastwide analysis of natural environments, active processes, land use, mineral and energy resources, hydrologic parameters, biologic assemblages, and cultural features. The Atlas is intended to be open-ended and subject to update (Brown and others, 1976), while serving as a historical reference from which rates and directions of change can be delineated. The preparation of overlays is an initial step in delineating the types of ongoing changes.

COASTAL CHANGES DELINEATED

The accompanying tables 2 through 8 combine additions to and deletions from the Environmental Geology map into a single list of changes. The categories shown are abbreviated from the explanation of each map sheet with the addition of a category for lakes, ponds, and man-made reservoirs, and for dredged channels. Note that changes in shape, size, and occurrence of water bodies, and alterations resulting from dredging and spoil disposal account for the vast majority of the items delineated on each map. Among the 1,105 changes detected within the area covered by the February 1975 aerial photographs, 43.6 percent were related to channel dredging and spoil disposal, 21.4 percent were related to both natural and man-induced alteration of ponds and reservoirs, and the remaining 35 percent were related to other naturally occurring changes. The approximate areal distribution of these changes is shown in figures 3 through 9, using a number corresponding to the listing in tables 2 through 8 as a map label. Where similar changes are very closely spaced only one number appears in that location on the map.

The greatest number of additions and deletions related to a specific natural active process were found on the Kingsville sheet (table 7). In northern Kenedy County, sand dunes, migrating under the influence of prevailing southeasterly winds (fig. 10), have shown substantial changes in shape and have left behind blowout areas with prominent aeolian grain. Changes are more widely distributed among a range of environmental geologic units on the other Coastal Atlas sheets.

Table 1. Types of ongoing changes in the Texas Coastal Zone.

- Dredging of navigation channels
- Spoil disposal in mounds or in creation of made land
- Boundary changes and drying up of lakes and ponds
- Creation of reservoirs for agriculture or industry
- Marsh succession over filled ponds
- Marsh destruction caused by housing development
- Marsh-plant colonization of new substrate (washovers)
- Reworking of subaerial spoil
- Subaqueous spoil deposition
- Shoreline erosion and accretion, especially at tidal inlets and river mouths
- Changes in flood- and ebb-tidal deltas
- Washover fan and channel development
- Grassflat, mudflat and tidal-flat alteration
- Sand dune migration and wind deflation
- Alteration of barrier flats, fore-island and back-island dunes and beach ridges
- Configuration changes of tidal channels and ephemeral streams

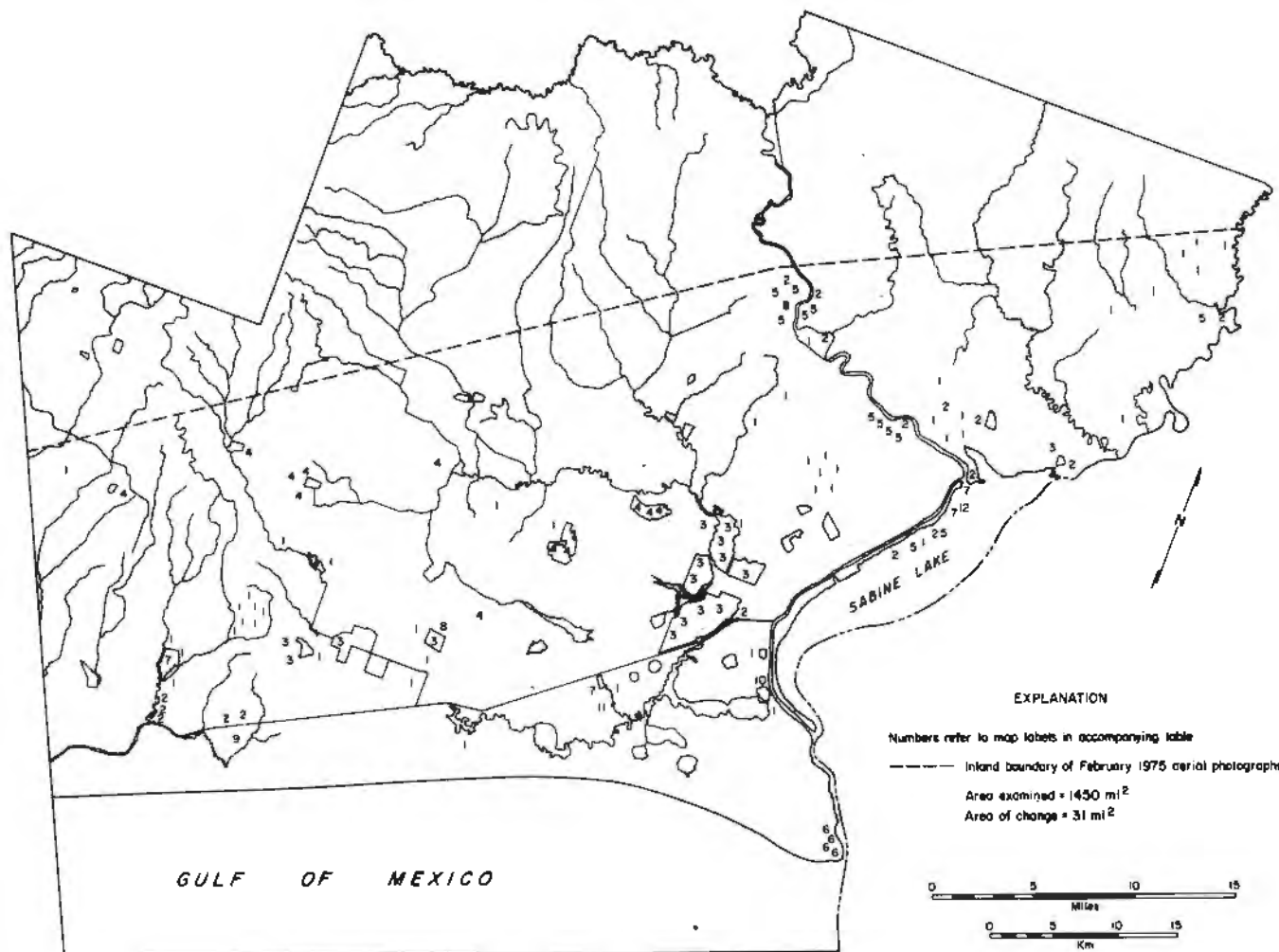


Figure 3. Change locations for Environmental Geology map, Beaumont - Port Arthur area.

Table 2. Categories of change for the Environmental Geology map,
Beaumont - Port Arthur area.

Units shown are the new categories at each location,
listed in order of frequency

<u>Map Label</u>	<u>Category</u>	<u>Number of Occurrences</u>
1	Lake, pond, or man-made reservoir	82
2	Dredged channel	17
3	Marsh, fresh- to brackish-water	15
4	Marsh, fresh-water	12
5	Spoil heap, subaerial	17
6	Coastal mudflat	4
7	Made land	4
8	Reworked spoil, subaerial	2
9	Spoil, subaqueous	2
10	Marsh, brackish-water	1
11	Coastal pond, mud-filled	1
12	Bay mud and silt	<u>1</u>

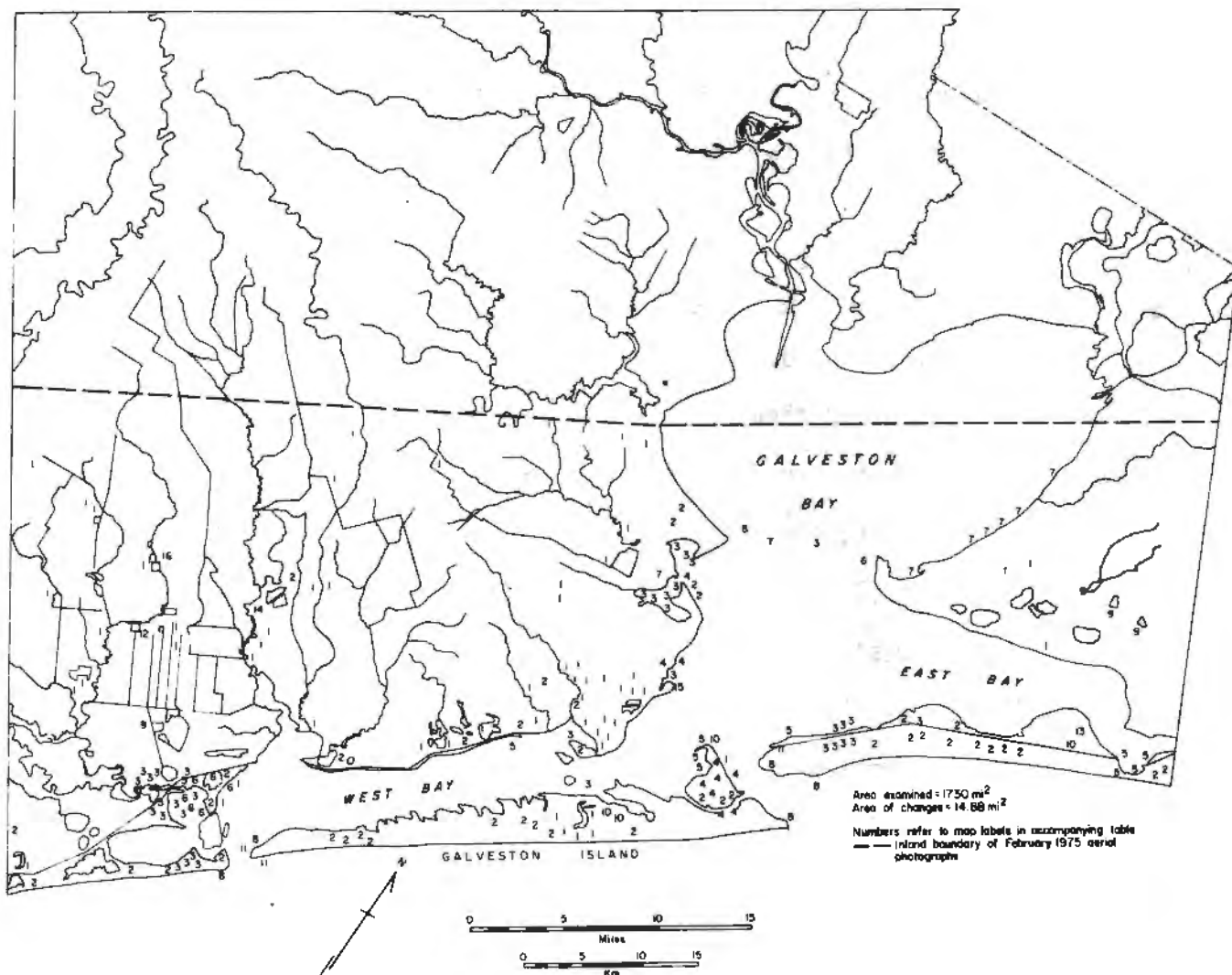


Figure 4. Change locations for Environmental Geology map, Galveston - Houston area.

Table 3. Categories of change for the Environmental Geology map,
Galveston - Houston area.

Units shown are the new categories at each location,
listed in order of frequency.

<u>Map Label</u>	<u>Category</u>	<u>Number of Occurrences</u>
1	Lake, pond, or man-made reservoir	66
2	Dredged channel	44
3	Spoil heap, subaerial	42
4	Made land	11
5	Reworked spoil, subaerial	10
6	Oyster reef	8
7	Spoil, subaqueous	8
8	Beach	5
9	Marsh, fresh- to brackish-water	4
10	Marsh, salt-water	4
11	Inlet-related shoal, sand	3
12	Interdistributary mud	1
13	Tidal creek, fresh- to brackish-water	1
14	Marsh, fresh-water	1
15	Bay-margin sand	1
16	Lake or pond, dry, man-made, or natural	<u>1</u>
		210

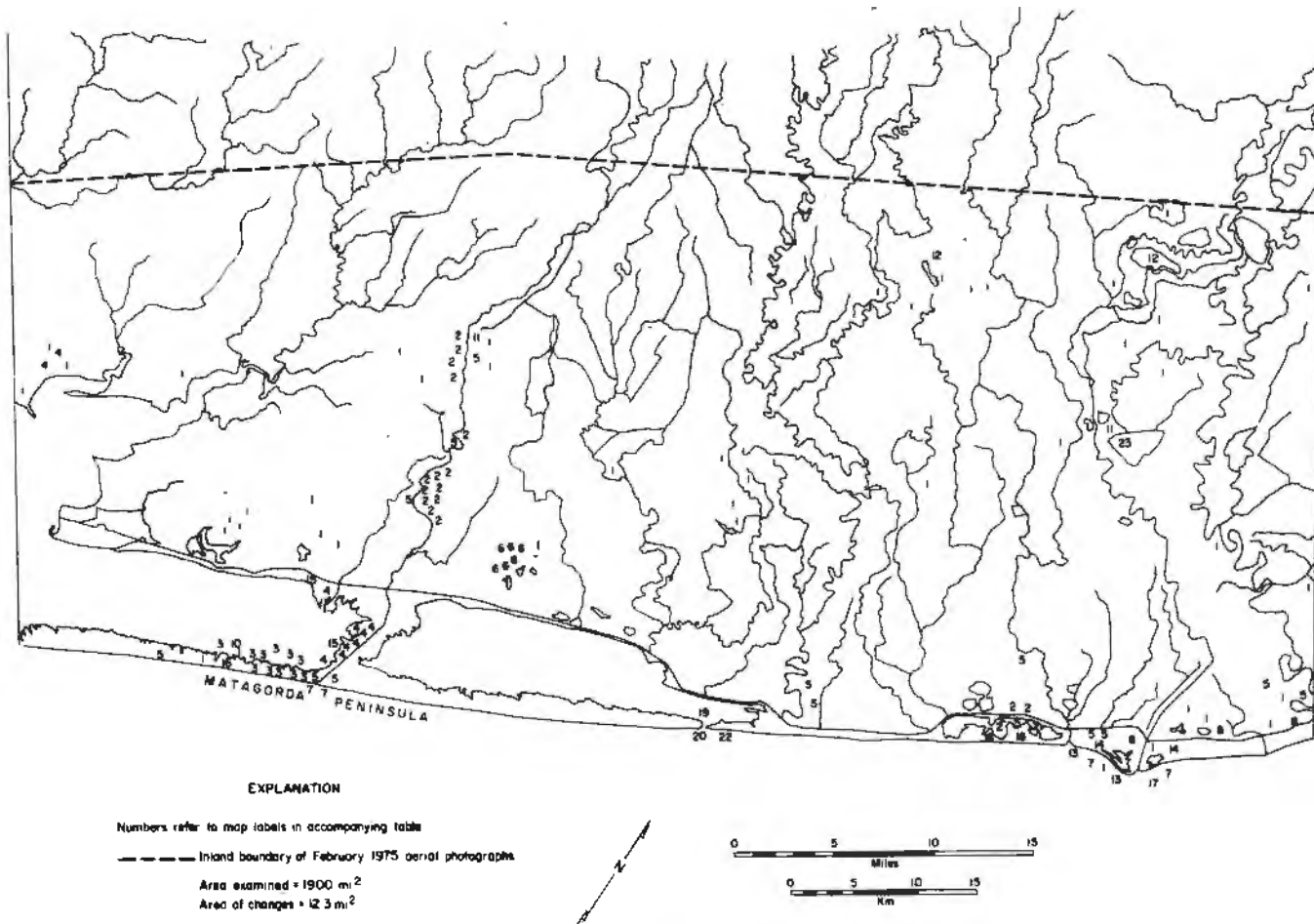


Figure 5. Change locations for Environmental Geology map, Bay City - Freeport area.

Table 4. Categories of change for the Environmental Geology map,
Bay City - Freeport area.

Units shown are the new categories at each location,
listed in order of frequency.

Map Label	Category	Number of Occurrences
1	Lake, pond, or man-made reservoir	53
2	Spoil heap, subaerial	20
3	Wind-tidal flat, barren, subaerial	15
4	Marsh, salt-water	11
5	Dredged channel	12
6	Distributary and fluvial sands and silts	6
7	Beach, sand and shell	4
8	Marsh, fresh- to brackish-water	3
9	Tidal channel, active	3
10	Grassflat, muddy sand with shell	3
11	Fluvial sand and floodbasin mud	2
12	Marsh, fresh-water	3
13	Active beach ridge (Brazos delta)	2
14	Interridge area (Brazos delta)	2
15	Channel mouth bar	2
16	Washover fan, sand	2
17	Delta-front sand, silt, and mud	1
18	Washover channel	1
19	Flood-tidal delta, sand	1
20	Ebb-tidal delta	1
21	Bay-margin laminated sand	1
22	Inlet-related shoal	1
23	Made land	1
		150

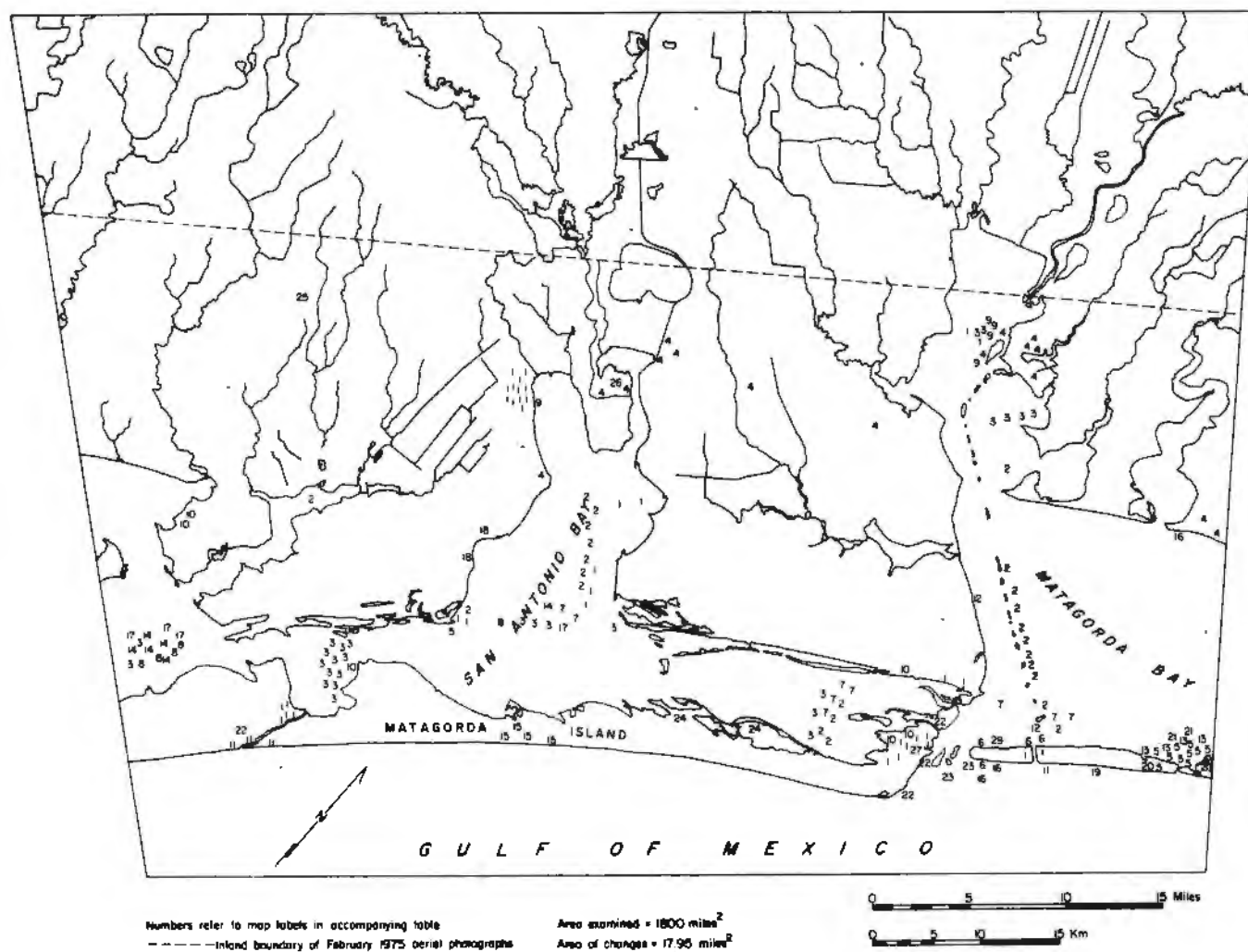


Figure 6. Change locations for Environmental Geology map, Port Lavaca area.

Table 5. Categories of change for the Environmental Geology map,
Port Lavaca area.

Units shown are the new categories at each location,
listed in order of frequency.

Map Label	Category	Number of Occurrences
1	Spoil heap, subaerial	39
2	Spoil, subaqueous	27
3	Bay mud	24
4	Lake, pond, or man-made reservoir	19
5	Marsh, salt-water	13
6	Bay-margin sand	8
7	Bay and bay-margin sandy mud	9
8	Bay sand and muddy sand	6
9	Made land	6
10	Dredged channel	6
11	Beach, sand and shell	5
12	Bay-margin sand and shell berms	5
13	Wind-tidal flat	5
14	Oyster-reef flank	5
15	Stabilized blowout dune complex	4
16	Ebb-tidal delta, sand, subaqueous	3
17	Oyster reef	3
18	Barrier strandplain sand	2
19	Fore-island dune ridge	2
20	Beach ridge and barrier flat	2
21	Washover fan, sand, subaerial	2
22	Tidal channel, active	4
23	Inlet-related shoal, sand	2
24	Beach ridge and berm, abandoned	2
25	Lakes and ponds, mud/sandy mud-filled	1
26	Marsh, fresh- to brackish-water	1
27	Delta-front sand	1
28	Washover channel, normally inactive	1
29	Flood-tidal delta, sand, subaqueous	1

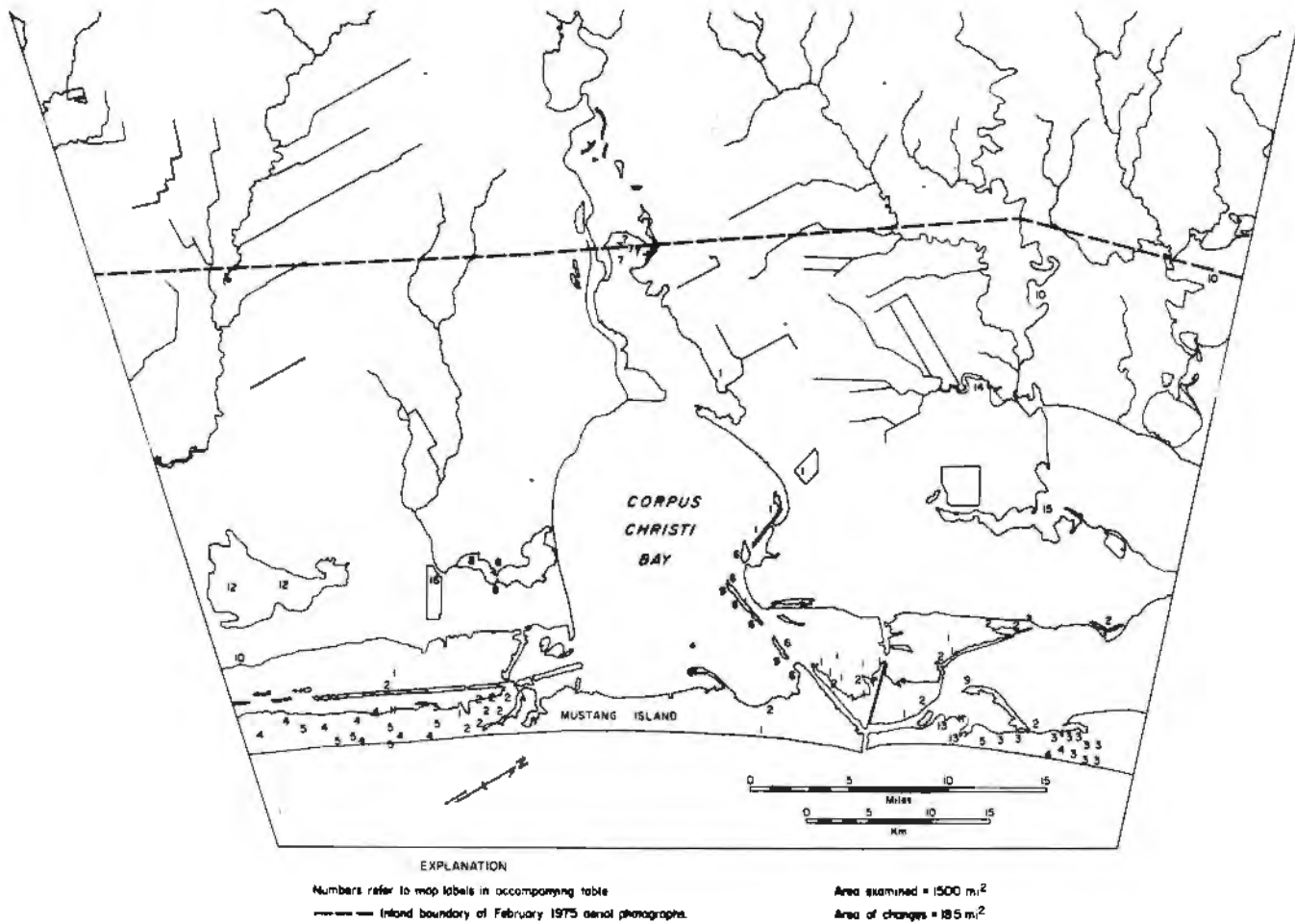


Figure 7. Change locations for Environmental Geology map, Corpus Christi area.

Table 6. Categories of change for the Environmental Geology map,
Corpus Christi area.

Units shown are the new categories at each location,
listed in order of frequency.

<u>Map Label</u>	<u>Category</u>	<u>Number of Occurrences</u>
1	Spoil heap, subaerial	20
2	Dredged channel	17
3	Stabilized blowout dune complex	11
4	Beach ridge and barrier flat	10
5	Fore-island blowout dunes	7
6	Reworked spoil, subaerial	6
7	Oyster reef	7
8	Marsh, fresh- to brackish-water	3
9	Spoil subaqueous	3
10	Lake, pond, or man-made reservoir	3
11	Wind-tidal flat	2
12	Marsh, fresh-water	3
13	Washover, distal fan, subaerial	2
14	Small ephemeral stream, alluvium	1
15	Bay and lagoon mud	1
16	Made land	<u>1</u>

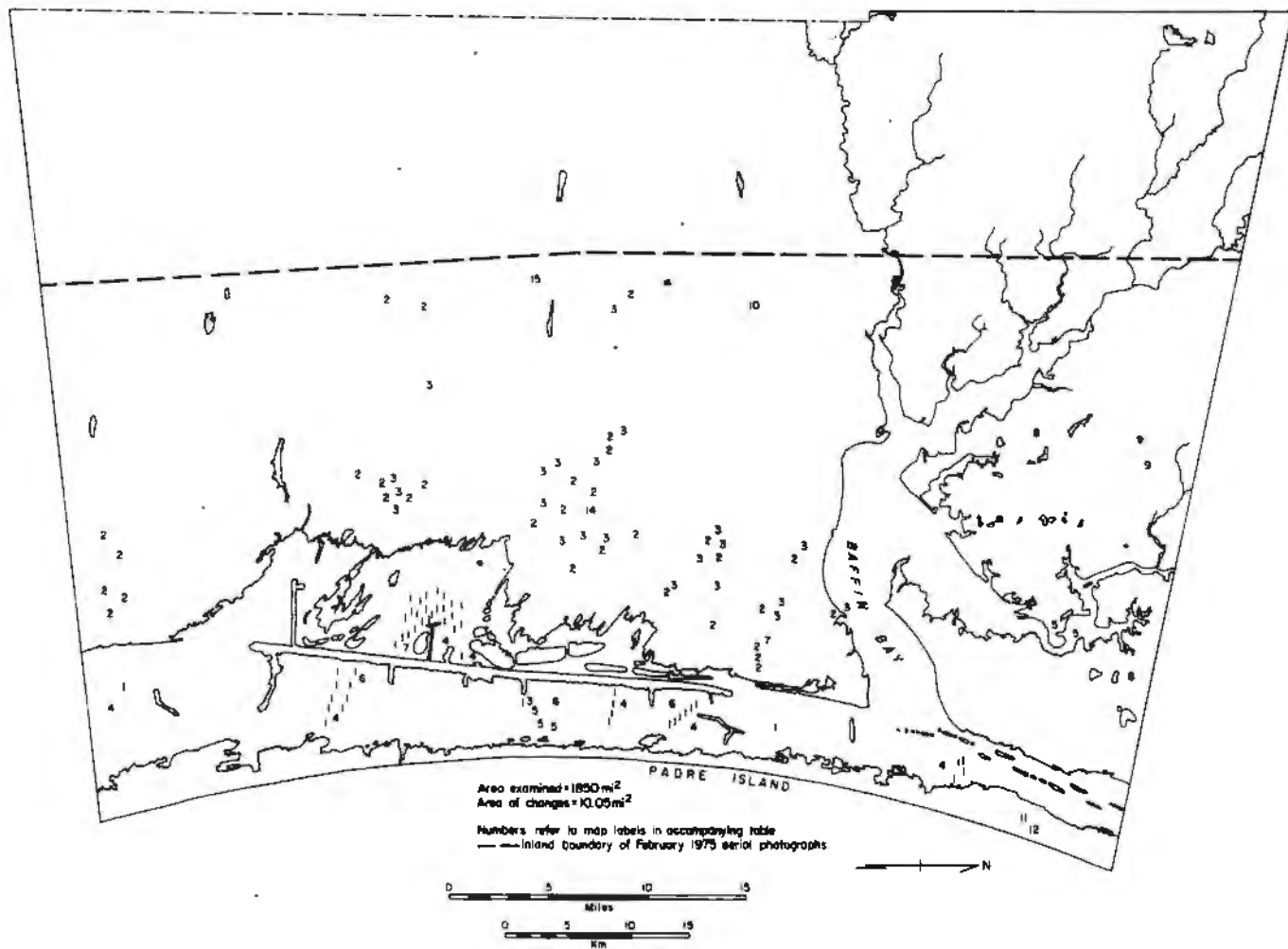


Figure 8. Change locations for Environmental Geology map, Kingsville area.

Table 7. Categories of change for the Environmental Geology map,
Kingsville area.

Units shown are the new categories at each location,
listed in order of frequency.

Map Label	Category	Number of Occurrences
1	Spoil heap, subaerial	51
2	Active dune blowout areas	34
3	Active dune complex	24
4	Dredged channel	7
5	Bay and lagoon sand, muddy	5
6	Reworked spoil, subaerial	3
7	Lake, pond, or man-made reservoir	3
8	Marsh, fresh-water	2
9	Lake or pond, mud-filled	2
10	Loess sheet, thin, discontinuous	1
11	Barrier flat, sand and shell	1
12	Back-island dune field	1
13	Wind-tidal flat, submergent/emergent	1
14	Transitional, wind-tidal flat/aeolian sand	1
15	Sand sheet, relict dune grain	1

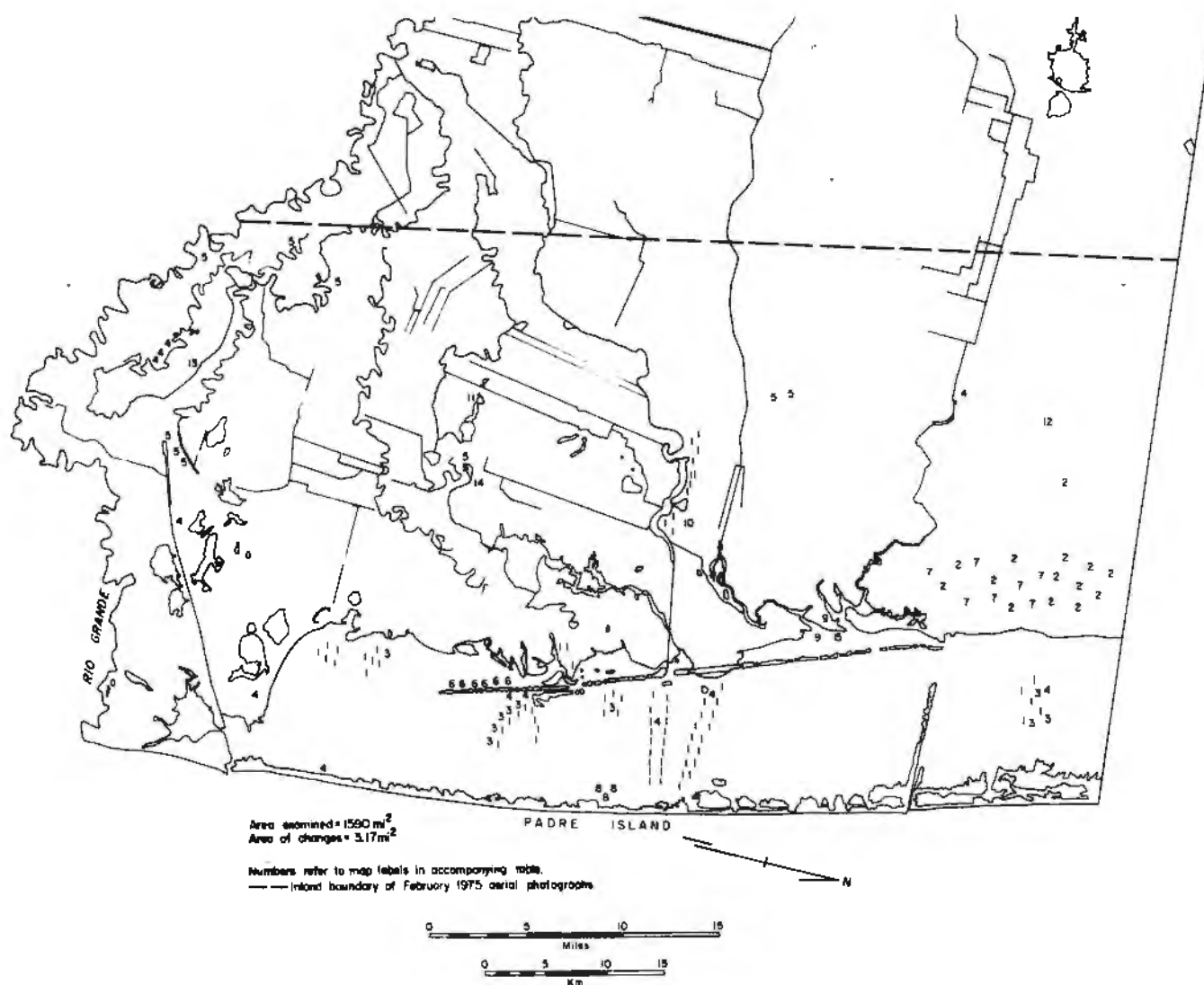


Figure 9. Change locations for Environmental Geology map, Brownsville - Harlingen area.

Table 8. Categories of change for the Environmental Geology map,
Brownsville - Harlingen area.

Units shown are new categories at each location,
listed in order of frequency.

<u>Map Label</u>	<u>Category</u>	<u>Number of Occurrences</u>
1	Spoil heap, subaerial	78
2	Active dune blowout areas	14
3	Spoil, subaqueous	11
4	Dredged channel	11
5	Lake, pond, or man-made reservoir	10
6	Reworked spoil, subaerial	6
7	Active dune complex	4
8	Washover distributary channel, active	3
9	Wind-tidal flat	2
10	Meanderbelt sand, depositional grain	1
11	Lake or pond, mud-filled	1
12	Clay-sand dunes	1
13	Floodbasin overbank mud	1
14	Abandoned channel course	1
15	Grassflat	<u>1</u>
		145



Figure 10. The dune indicated by the arrow has migrated across the Baffin Bay shoreline since the late 1950's (Kenedy County, Texas; length of area covered by photograph is approximately 14.8 miles; from Landsat image 2376-16172, band 7, February 2, 1976).

CONCLUSIONS

1. Ongoing alterations of the Texas Coastal Zone are related to natural processes and economic development of the region.

2. Of over 1,000 changes, which occurred within the previously mapped area between the late 1950's and February 1975, nearly one-half were related to channel dredging, spoil disposal, reworking of existing spoil, and creation of made land for economic development.

3. The environmental changes which have taken place since the Edgar Tobin Aerial Surveys photomosaics were compiled in 1955-1959 are of relatively minor extent and do not detract from the Environmental Geologic Atlas of the Texas Coastal Zone as a thorough, detailed, but open-ended compilation of resource information.

4. The total area affected by the changes averages 0.9 percent of the map area examined, that is, only 107.36 square miles of an 11,820 square mile area.

ACKNOWLEDGMENTS

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