PERFORMANCE REPORT

As required by

ENDANGERED SPECIES ACT, SECTION 6

TEXAS

Project E-1-2

ENDANGERED AND THREATENED SPECIES CONSERVATION

Job No. 9.2: Eskimo Curlew Habitat Identification Status Survey

Principal Investigator: Catrina Martin

Larry D. McKinney, Ph.D.
Director
Resource Protection Division

Andrew Sansom
Executive Director
Texas Parks and Wildlife Department

December 20, 1990

PERFORMANCE REPORT

STATE: Texas **PROJECT NO.:** E-1

PROJECT TITLE: Endangered and Threatened Species Conservation.

PERIOD COVERED: September 1, 1989 - August 31, 1990

JOB NUMBER: 9.2

JOB TITLE: Eskimo Curlew Habitat Identification Status Survey

JOB OBJECTIVE: To quantitatively characterize a habitat profile for confirmed and possible recent Eskimo Curlew sightings, identify sites for systematic monitoring during migration periods, and provide protection for any use areas documented.

YEAR OBJECTIVES:

1. To compile curlew sighting records for Texas during the past 40 years and associated physical data sources.

2. To develop quantitative and qualitative models of physical site characteristics that profile curlew use areas.

ABSTRACT

Researchers at the University of North Texas were contracted to compile historical sighting records of the Eskimo Curlew in Texas and to attempt to characterize habitat using LandSat reflectance data. A total of 68 sightings were compiled. Habitat appears to be nonspecific pasture or cropland, primarily in coastal areas. No distinctive reflectance value was determined.

ACCOMPLISHMENTS

See attached report.

SIGNIFICANT DEVIATIONS

An attempt was made to characterize habitat through use of LandSat imagery, rather than by use of multivariate analysis, as originally proposed. Lack of detail for most sightings and generalist habitat characteristics would limit effectiveness of both these approaches.

PREPARED BY: Lee Ann Linam — 1-30-91

Lee Ann Linam — **Date**

Endangered Species Biologist

Title

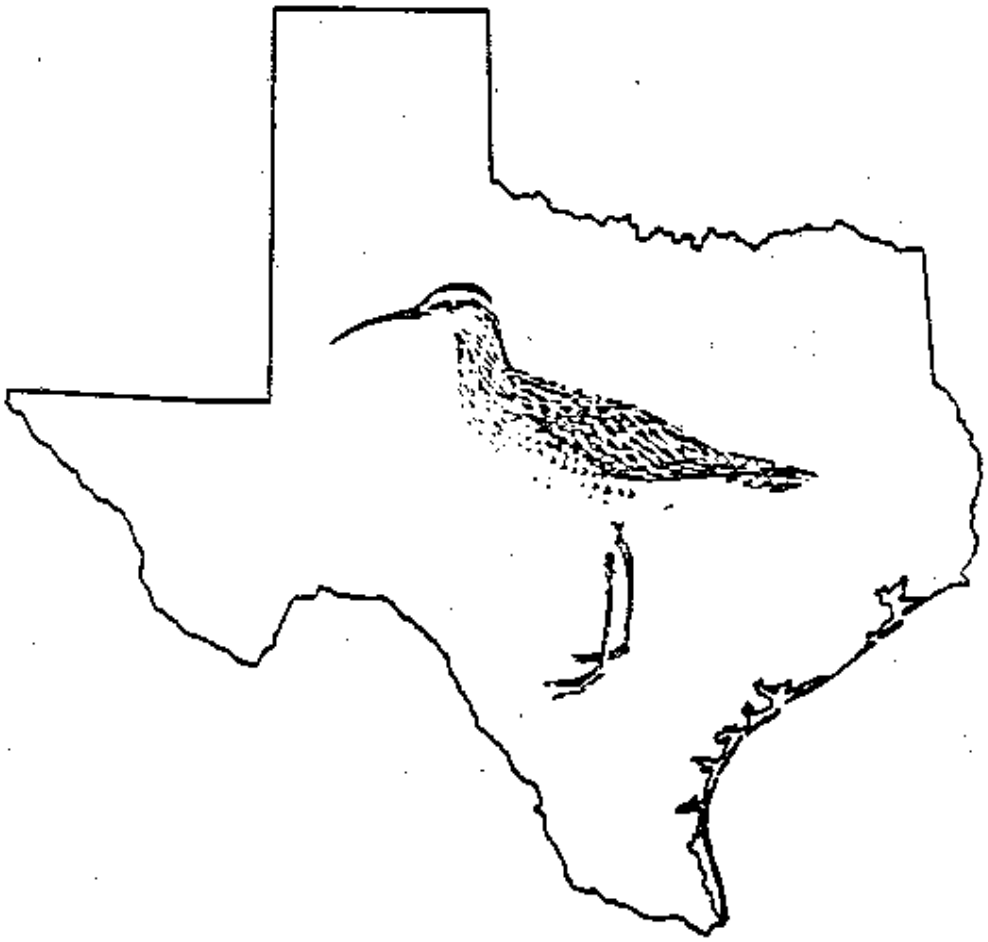
APPROVED BY: — 1-31-91

Larry D. McKinney, Ph.D. — **Date**

Director, Resource Protection Division

Title

CHARACTERIZATION OF HISTORICAL ESKIMO CURLEW HABITAT IN TEXAS



Prepared For:
Texas Parks and Wildlife

Prepared By:
Institute of Applied Sciences
Center for Remote Sensing and Landuse Analyses
University of North Texas
Denton, Texas 76203-3078

January 1991

CHARACTERIZATION OF HISTORICAL ESKIMO CURLEW HABITAT IN TEXAS

By

Samuel F. Atkinson
Gary M. Church
Denice M. Shaw

Institute of Applied Sciences
Center for Remote Sensing and Landuse Analyses
University of North Texas
Denton, Texas 76203-3078

January 1991

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1 INTRODUCTION

This report describes a pilot study to characterize habitat for confirmed and possible sightings of the Eskimo Curlew (Numenius borealis) in Texas. The research involved the integration of sightings and field survey with remote sensing and Geographic Information System (GIS) technologies. The objectives of the project were to compile Eskimo Curlew sightings in Texas from sources including published literature, the U.S. Fish and Wildlife Service, and the Texas Ornithological Society and to identify potential Eskimo Curlew habitat with historical digital satellite imagery. From the satellite imagery, areas which meet the habitat criteria gleaned from the literature will be identified and mapped. It is recommended that these areas be monitored for Eskimo Curlews.

1.1 DESCRIPTION OF THE ESKIMO CURLEW

A detailed literature review was conducted to document and summarize historical sightings of the Eskimo Curlew in Texas since the mid-1800s. Throughout the literature, frequent mention is made of the care which must be taken for an accurate identification of this species because of its similarity to other species such as the Whimbrel (Numenius phaeopus), Long-billed Curlew (Numenius americanus), and Little Curlew (Numenius minutus) (Emanuel, 1962; Heiser, 1945; Williams, 1959). Gollop et al. (1986) suggest that "a 'good' identification of an Eskimo Curlew is facilitated by familiarity or field comparison with Whimbrels (and other shorebirds) for length, bulk and bill, and by careful attention to the underwing---the lack of barring on the primaries and the cinnamon wing lining. Eskimo Curlews on the ground will occasionally raise their wings above the back permitting determination of details of the underwing".

Some identifying characteristics of the Eskimo Curlew include (Gollop et al., 1986):

1. Underside of primaries unbarred
2. Wing linings pale to rich cinnamon
3. None to indistinct central head stripe
4. Faint eyestripe
5. General plumage warm and in browns
6. Base of lower mandible flesh-colored, pink, for less than half its length
7. Leg color dark green, dark brown, dark gray-blue (Emanuel, 1962)
8. Posterior leg scutes hexagonal, reticulated
9. Weight = 270-454 g
10. Stretched length = 30-38 cm (12-15 in)
11. Tarsus = 40-46 mm (1.57-1.81 in)
12. Bill = 42-65 mm (1.65-2.56 in)
13. Bill:Head ratio = 1.25:1 to 1.75:1

Oberholser (n.d.) provides this description of the Eskimo Curlew's field traits:

> "Very similar to the Hudsonian Curlew, but size decidedly smaller; length about 14.00 inches; build more slender; bill decidedly shorter, less curved downward and thinner; crown without a broad distinct central light buffy stripe; breast with dark V-shaped markings; outer wing-quills (primaries) uniform dark brown without cinnamon markings, obvious in the spread wing. Now practically extinct".

Emanuel (1962) mentions that the Eskimo Curlew sighted March 22, 1959 on Galveston Island was buffy in color rather than grayish like a Whimbrel. In addition to the above comparisons between the Eskimo Curlew and the Whimbrel, Scott (1987) comments that the curlew's upperparts are darker and its crown is less strongly patterned.

Unfortunately, some of the uncertainty in the correct identification of the Eskimo Curlew experienced in the past, even by expert birders, was due to inconsistent descriptions in field guides of its physical characteristics, such as its leg color (Emanuel, 1962). At times, however, the simultaneous sighting of the Eskimo Curlew in close proximity to

one or more of the bird species with which it was commonly seen and/or mistaken for provided the opportunity for comparing their physical traits in order to arrive at a more accurate identification (Williams, 1959; Heiser, 1945; Emanuel, 1962).

1.2 ESKIMO CURLEW HABITAT

The degree to which one can be certain of the accuracy of Eskimo Curlew habitat description and characterization depends on the degree to which the curlew is accurately identified. There are several species which occupy habitat similar to that of the Eskimo Curlew. These include the Common Golden Plover (Pluvialis dominica), Buff-breasted Sandpiper (Tryngites subruficollis), Black-bellied Plover (Pluvialis squatarola), Long-billed Curlew (Numenius americanus), Upland Plover (Bartramia longicauda), and Whimbrel (Numenius phaeopus). Gollop et al. (1986) report that the Eskimo Curlew's most common companion is the Golden Plover.

Gollop et al. (1986) gave the following account of Eskimo Curlew habitat:

> "Like most birds these curlews used a variety of habitats in their annual travels. All were open, from the grassy 'Barren Grounds' for breeding to fall concentration areas at the delta of the Kobuk River in Alaska, the 'low hills, partly barren, and the rest covered with small bad-spruce' in Labrador and the 'sterile mountainous tracts' of eastern Quebec. When they were not on the mud flats or sandbars, curlews preferred headlands and hills within a few kilometers of the sea. They also used old fields and closely grazed pastures in Massachusetts, Texas and elsewhere, and broad dry or marshy pampas in Argentina.
>
> Burned-over prairies and marshes were particularly attractive to migrating curlews in Nebraska, Illinois and Massachusetts, while on Prince Edward Island, Illinois and Nebraska, they were found following the plough in wheat and corn fields. In Maine they once used a patch of clover. In Texas one bird appeared to use the same field for at least three weeks. Curlews roosted on the beaches along the coast but were rarely found near water in the Midwestern states".

Pertaining to the April 29, 1945 sighting of two Eskimo Curlews among a large group of marsh and shore birds, Heiser (1945) stated: "All were feeding over a wide area of sand flats, shallow ponds, and grassy patches near West Bay on Galveston island".

Williams (1959) stated "The pasture in which the bird was seen most often was being grazed by cattle; it was well drained and gently rolling, with grass about three to four inches high".

According to Oberholser (n.d.), the Eskimo Curlew in Texas

> "frequented principally the plains and the prairies, both in the interior and in the coast region. Although, like other species of shorebirds, it was found about the ponds, lakes, sloughs, and streams, it also ranged the dry lands often at some distance from water. In cultivated areas it often visited the plowed fields. In the early days during the spring migration this curlew was exceedingly abundant on the Texas prairies".

1.3 ESKIMO CURLEW MIGRATION

Figure 1 illustrates the Eskimo Curlew's path of migration. Our literature review revealed the following accounts of this migration:

> "They flew in that peculiar manner which distinguishes the curlews from all other birds in flight, a sort of wedge shape, the sides of which were constantly swaying back and forth like a cloud of smoke wafted by the lightest zepher
> [sic]....Long, dangling lines, either perpendicular or horizontal, the lower parts of which whirl, rise, or twist spirally, while the apex of the flock is seemingly at rest" (Turner in Bent, 1962).

Gollop et al. (1986) indicate that the largest part of the Eskimo Curlew population

> "began its southward journey by migrating east, possibly from Siberia and certainly across Alaska, the Northwest Territories and the tip of Ungava, Quebec, before turning south down the east coast of Canada. While there are records of flocking in Alaska, nothing is known about resting areas between there and Hamilton Inlet, Labrador---a distance of more than 2400 km (1500 mi.). In Labrador the birds concentrated along a strip of shoreline less than 160 km (100 mi.) long and probably not more than 10 km (6 mi.) wide.
>
> At Cartwright Harbour, Labrador, the first birds arrived as early as 28 July and they regularly appeared in the first week of August. Usually they stayed in large numbers through the month but we do not know whether individual birds stayed that long or whether there was a steady turnover. Final departures usually took place

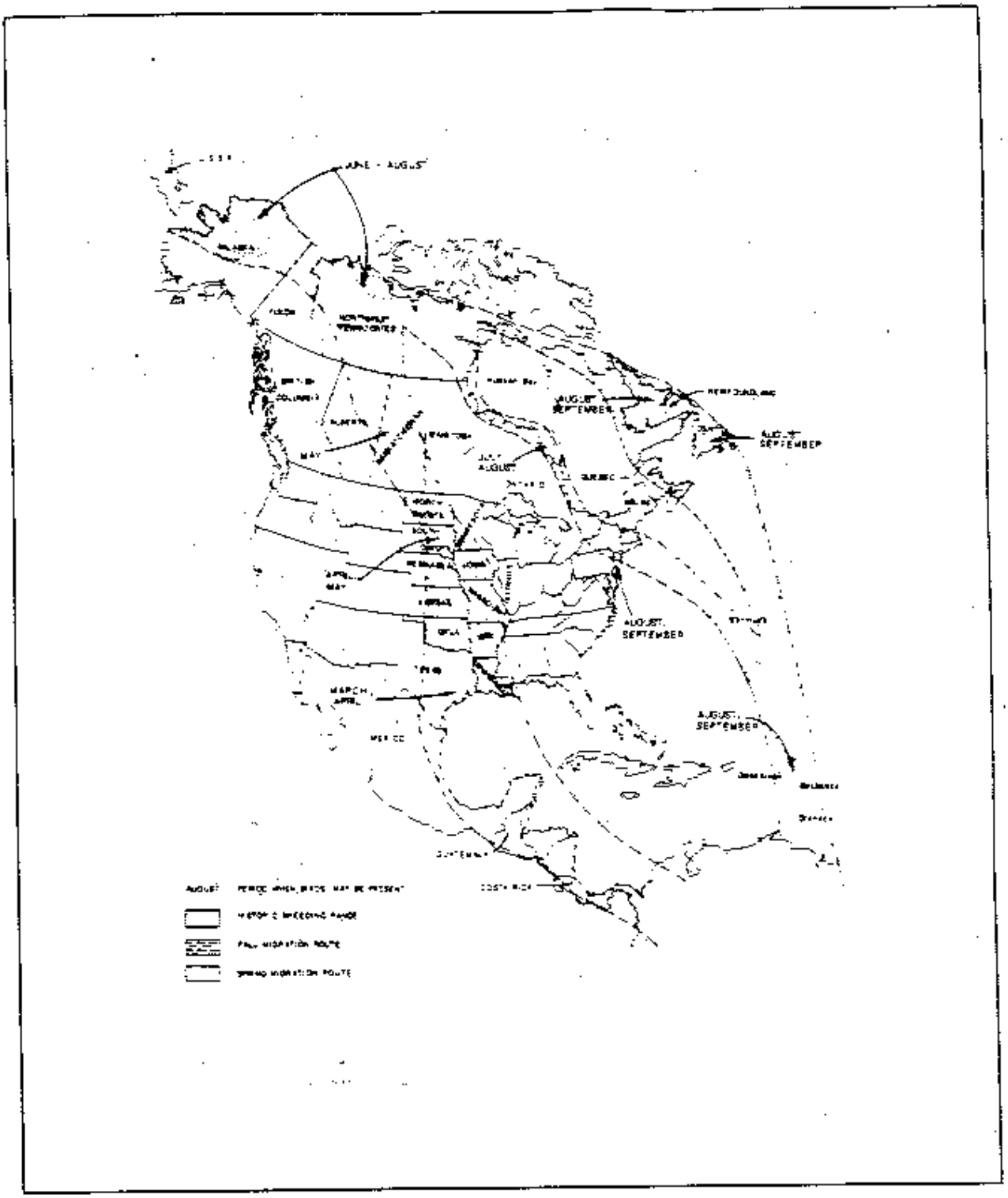


Figure 1: Eskimo Curlew Migration Path (U.S. Fish and Wildlife Service, 1990).

during the last two weeks of September and curlews in October were a rarity. In migration the birds flew high, frequently changing flock shape and flight altitude.

As for predators on migration, Audubon found curlew remains below a Gyrfalcon nest near Bradore, Quebec, and Coues watched a Merlin foraging among immense flocks of curlews in Labradore.

The birds may have followed both shores of Newfoundland after taking off from Labrador and the north shore of the Gulf of St. Lawrence in eastern Quebec. There are suggestions that stopovers even as far north as Iles de la Madeleine, New Brunswick, Nova Scotia and Prince Edward Island were storm-related. Certainly the curlews paid little attention to the Atlantic coast of the United States unless head-on storms turned them westward. When this occurred, Cape Cod and Nantucket, Massachusetts, reaching out into the sea as they do, were their first landfall. However, migrating curlews and adverse storms seldom coincided.

Once the birds left Labrador, their route was over the ocean, apparently east of Bermuda, with birds landing there and in the West Indies only if they flew into adverse weather. If they needed to rest during their day and night flight, they could settle onto the water. While landings were reported for the Guianas, reports are noticeably lacking on where the hordes regularly landed for the first time after a flight of 4000 to 5000 km (2500-3000 mi.). They passed through Brazil and Paraguay, some wintering in Uruguay but many more in southern Argentina, where the first birds arrived in September. Fall migration took two to three months.

Spring migration probably began in late February or in March. The route taken through South America remains a mystery although there is some evidence that Central America was used and that the Yucatan Peninsula may have been the jumping-off point for a flight across the Gulf of Mexico to Texas. In March Eskimo Curlews could be found from Argentina to Nebraska. Migration may have slowed through Texas, Oklahoma, Kansas and Nebraska, although in May the birds were found from Texas to Alaska. There are no verified records for North Dakota or Saskatchewan, suggesting either an overflight to the breeding grounds or an absence of observers at the right time and place through the 1800s. From South Dakota to the Anderson River, NWT.(Northwest Territory), is 3200 km (2000 mi.), not a long flight for this species".

Oberholser (n.d.) makes the following comments about the curlew's migration:

"Like the other curlews this bird often assembles, particularly during the migration seasons, into great flocks of several hundred, or

perhaps thousands of individuals, and these flocks moved in more or less wedge-shaped formation, similar to that of the Canada Goose and the other curlews, and the evolutions of some of these large flocks was marvelously interesting to see. It moved also in scattered or rather compact smaller groups, particularly when migrating at a considerable height from the ground, but when flying from place to place for shorter distances often close to the ground or water. Its flight is sometimes rather swift, and a little resembles that of the Golden Plover, particularly if not protracted; but at other times it is much more like that of the other American curlews. On the ground it walks and runs much as the Hudsonian Curlew, and its general habits are similar.

From the breeding range of this species in northern Mackenzie, the Eskimo Curlew migrated in great numbers eastward or southeastward to Labrador, and spent a brief time in that region to fatten on the berries that are so numerous there. It thence moved southward along the Atlantic coast of the United States and across the eastern part of the West Indies to South America, then on to the pampas of Argentina. In the spring it returned to its breeding grounds mostly through the Mississippi valley and central Canada. If fair weather prevailed the birds would fly probably from Nova Scotia to the Lesser Antilles in a single flight, but if they were beset by storms or adverse winds they would stop sometimes in large numbers along the coast of the northeastern United States".

Regarding the Eskimo Curlew's Texas migration range, Oberholser (n.d.) states that, in the west, the species has been seen in Eliasville, Lampasas, "the plains along the Rio Grande in the extreme central western corner" of the state, Ft. Stockton, Boerne, and San Antonio. He also mentions the bird has been observed east to Brownsville, the northern end of Padre Island, Corpus Christi, Victoria County, Calhoun County, Galveston Island, Long Point, Rice, Wise County, Gainesville, and Clarksville.

1.4 ESKIMO CURLEW STATUS

The Eskimo Curlew is listed by the USFWS as an endangered species (Gollop et al., 1986), and may already be extinct. According to Gollop et al. (1986), "for all the present century the Eskimo Curlew has been an endangered species. It has not been reported with certainty in at least 30 of the last 86 years. Since 1916, sightings have always been of fewer than 25 birds at a time, most often one or two". Regarding the

curlew's status in Texas, these authors report: "STATUS: Regular common spring migrant. RECENTLY: Irregular rare spring". Scott (1987) comments that "this species is almost extinct; identification must be made with great care".

With respect to the Eskimo Curlew's former status and likely reason for its decline, Gollop et al. (1986) have this to say:

> "If, as alleged, Eskimo Curlews were among the birds that guided Columbus to the New World five centuries ago, they unwittingly may have sown the seeds of their own destruction. They are a species that 150 years ago occurred in 'millions,' reminiscent of Passenger Pigeon numbers, and may have been second in abundance only to the Lesser Golden-Plover among some 50 species of North American shorebirds".

They add that "during the last half of the 19th century as 'civilization' expanded in the New World," curlews experienced a decline "from great abundance to great scarcity. How various factors contributed to this decline cannot be documented, but it is possible that curlews were killed by man every day of the year through the 1870s---a period of unregulated hunting and seemingly unlimited bird populations".

1.5 REMOTE SENSING OF ESKIMO CURLEW HABITAT

Remote sensing involves sampling of electromagnetic radiation (EMR) that is reflected or emitted from the earth's surface. Features on the earth can be characterized by their pattern of spectral emittance, their "spectral signature," across the electromagnetic spectrum (EMS). For example, Figure 2 displays spectral signatures typical of green vegetation, dry loam soil, and clear water. The relative spectral differences between these materials are the basis for classification of digital satellite imagery.

The digital imagery used for this study of Eskimo Curlew habitat was collected by LANDSAT 2. LANDSAT satellites orbit the earth in repetitive, near-polar, sun-synchronous paths at a nominal altitude of 917 km over the equator and circle the earth in 103 minutes (14 times per day). Every 18 days (252 orbits) the satellite returned to the same position.

Specifically, spectral data were recorded by an earth-viewing Multispectral Scanner

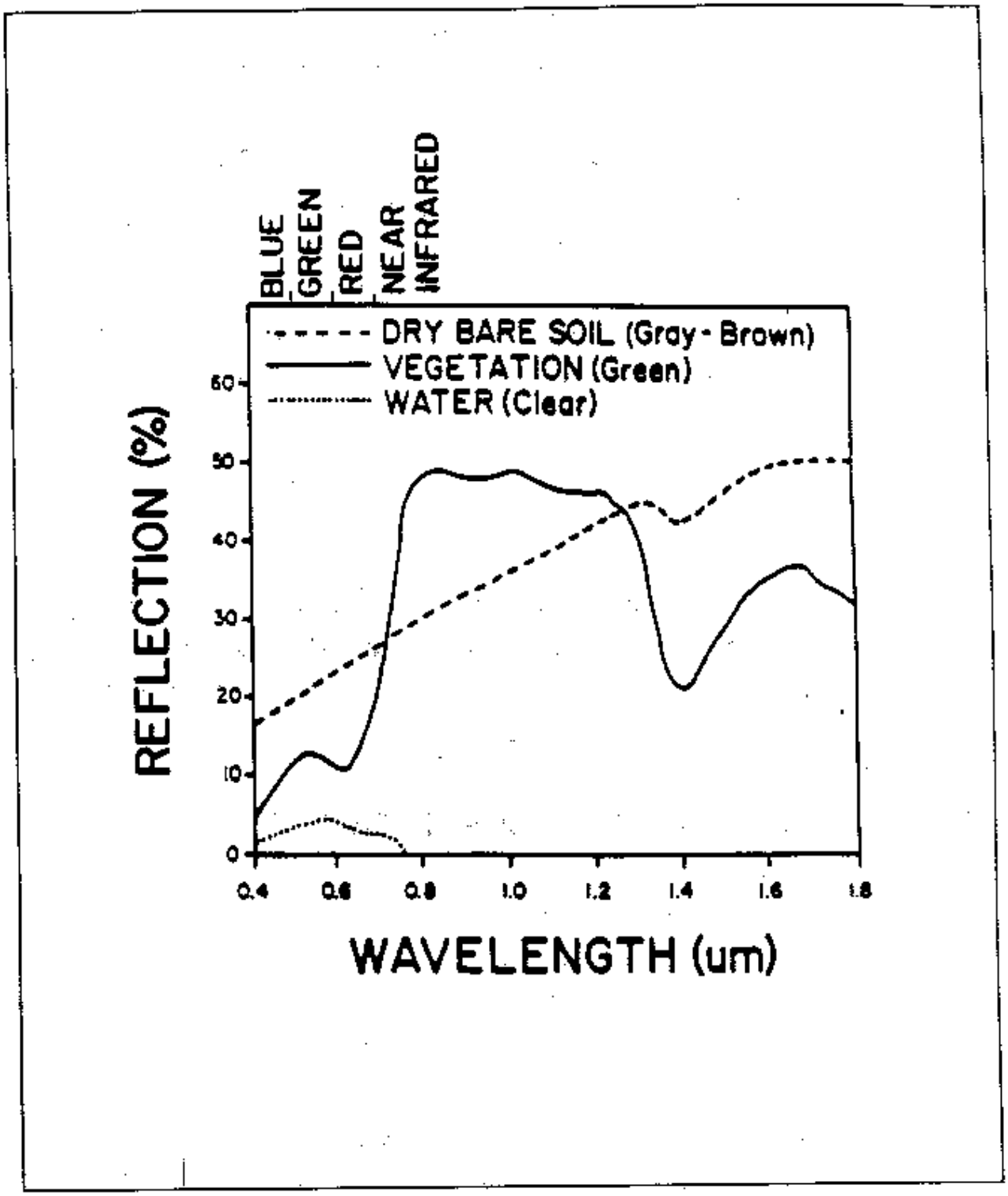


Figure 2: Typical Spectral Reflectance Curves for Vegetation, Water and Dry Bare Soil (Swain and Davis, 1978).

(MSS) which synchronously collected reflected radiation in four discrete spectral bands ranging from 0.5 to 1.1 um (micrometers). This range includes, in the visible spectrum, green and red as well as infrared radiation. Each geometrically corrected MSS image records data for an area of 185 by 170 km (116 by 106 mi) with a ground resolution of approximately 80 meters (Avery and Berlin, 1985). The unit of resolution (equivalent to 6400 m^2) is termed a "pixel" (short for picture element).

The specific MSS image used for this study was obtained from the EOSAT Company of Sioux Falls, South Dakota and was recorded on Feb. 1, 1976 (Scene ID No. 8237516112500, Path 27, Row 40). The general area of Texas covered by this image is shown in Figure 3.

2 METHODS

This portion of the report discusses the data collection for Eskimo Curlew sightings, the digital image classification and accuracy assessment techniques employed, and the methods of GIS analyses used to characterize habitat for the Eskimo Curlew. All image processing and GIS analyses were conducted with the Earth Resources Data Analysis System (ERDAS).

2.1 ESKIMO CURLEW SIGHTINGS: DATA COLLECTION

Information on curlew sightings was obtained from a review of the literature and personal contacts with ornithologists. Museums were contacted to request searches for Eskimo Curlew specimens obtained from Texas. At least two of the individuals mentioned in ACKNOWLEDGEMENTS, Arnold (personal communication) and Emanuel (1962), were involved in Eskimo Curlew sightings of the early 1960s on Galveston Island reported in the literature.

Some comments are needed about the term "sighting" and how our interpretation of it affects the number of observations we included in our Summary List of Eskimo Curlew Sightings (see Table 2 in Chapter 3). During the literature review, it became apparent that the number of Eskimo Curlews actually sighted on a particular date or over

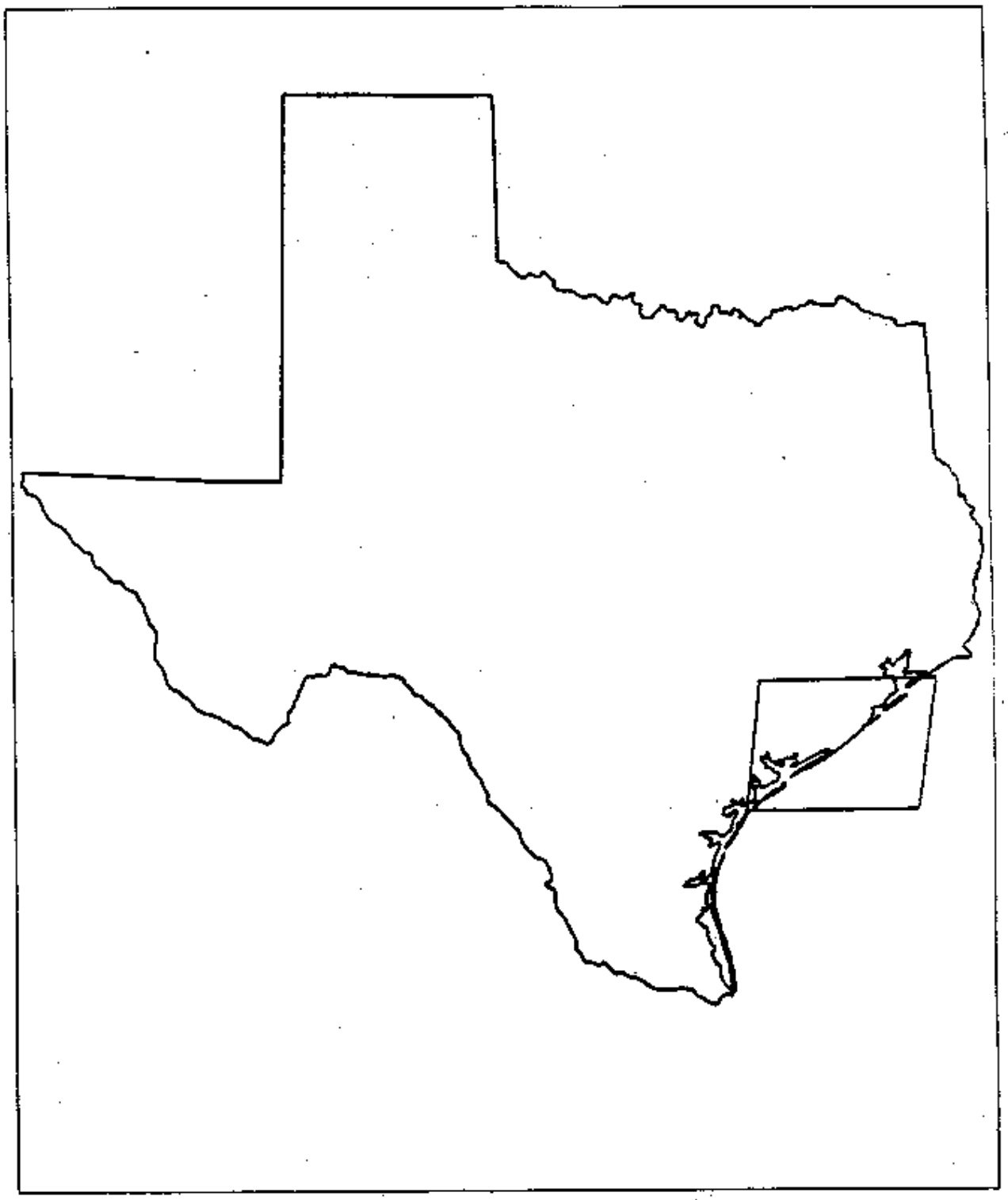


Figure 3: General Location of LANDSAT 2 MSS Image of the Study Area.

a particular range of dates might be more than the number reported. Some references contain charts which summarize curlew sightings over several years. An example from Blankinship and King (1984) is shown in Table 1. This table shows ten sightings, each evidently based upon a date or range of dates. However, there is evidence in the literature that a larger number of sightings were made. For example, Blankinship and King (1984) appear to interpret the March 22-April 26, 1959 entry as one sighting. From his participant's viewpoint, Emanuel (1962) clearly explains that an Eskimo Curlew was sighted on March 22, April 5, April 8, April 10, April 12, and April 26, and therefore, we would consider this as six sighting. The curlew seen on these six occasions may or may not have been the same bird, and the one seen on March 22 was "several miles" from the sightings made on the other five dates (Emanuel, 1962; Williams, 1959), but we shall make the assumption of six separate sightings.

Naturally, this can possibly affect the values in the "Number of Birds" column (whether or not the same bird was seen), the meaning of which is not always clear in the literature. Among the possible meanings for these values are: (a) the total number of curlews seen/captured during the time period given in the "Date" column; (b) the maximum number of curlews captured or seen together on any single occasion during the given period (the meaning which evidently applies to the April 29, 1945 sighting and the one which we have adopted - see Table 2 in Chapter 3); and (c) the number of curlews seen or captured each day over a range of dates. Gollop et al. (1986) appear to imply that meaning (b) could be correct when they mention that since 1916, sightings have always been of fewer than 25 birds at a time, most often one or two.

Since our compilation takes these matters into account, we hope it reflects a truer meaning of the term "sighting". Our point here is that when a bird is sighted and subsequently lost from view, it may or may not be the same bird observed at some later time. Whether it is the same bird or not, we consider that later time to be a different sighting and count it as such in our list of observations, especially if it is separated from previous sightings by substantial time and space (hours to years and several miles). In addition, we note that different observers were often involved in the separate observations we list.

Table 1: Summary Chart from Blankinship and King, 1984

Table 1. Eskimo Curlew sightings in Texas, 1945 to 1968.

Date	Number of Birds	Location[a]
Apr 29, 1945	2	Galveston Island
Apr 27-29, 1950	1	Aransas N.W.R.
Mar 22, Apr 18 &26, 1951	1	Galveston Island
Mar 22-Apr 26, 1959	1	Galveston Island
Apr 3-6, 1960	1	Galveston Island
Mar 31-Apr 3, 1961	1	Galveston Island
Mar 23-Apr 15, 1961	2[b]	Galveston Island
Apr 11-12, 1963	1	Rockport
Mar 29, 1964	2	Galveston Island
Apr 30, 1968	1	Rockport

[a]*Data from Emanuel (1962), Oberholser (1974), Iversen (1976), and Aldrich (1978)*
[b]*Verified by photographs (D.L. Bleitz).*

Upon review of the summary charts in the literature, we encountered similar situations for the sightings of April 3-6, 1960, March 31-April 3, 1961, and March 24-April 3 or 15, 1962, or, as in one chart, as merely 1960, 1961, and 1962. In our list of sightings, we separate each of these time periods out into individual observations based on descriptions in the literature about them.

Regarding the 1962 dates mentioned above, there is an apparent lack of consistency in the literature concerning two aspects of these sightings: the dates involved and the number of birds sighted. April 3 is the date given by Emanuel (1962), whereas the 15th is provided in Blankinship and King (1984) and Lasley (1989). The number of birds sighted is reported to be two in both Blankinship and King (1984) and Emanuel (1962), three or four by Weston and Williams (1965), and four by Gollop et al. (1986).

2.2 TECHNIQUES OF IMAGE CLASSIFICATION

Identification of landuse categories within the study area was achieved through the identification and extraction (from the satellite image) of significantly different clusters of spectral data called classes. Each class represents a category of interest, and was isolated on the basis of statistical differences in spectral reflectance.

Prior to classification, the pre-processing steps of georectification, data transformation, and signature extraction were required. Figure 4 illustrates these steps as part of the entire classification procedure.

2.2.1 GEORECTIFICATION

Georectification was performed on the digital satellite image to provide spatial reference to the Universal Transverse Mercator (UTM) coordinate system and to correct for error produced by changes in satellite attitude (roll, pitch, and yaw) and altitude. An outline of the rectification procedure is found in Figure 5.

Georectification was accomplished in two steps. First, recognizable features on the LANDSAT 2 MSS image were matched with specific locations on U.S. Geological

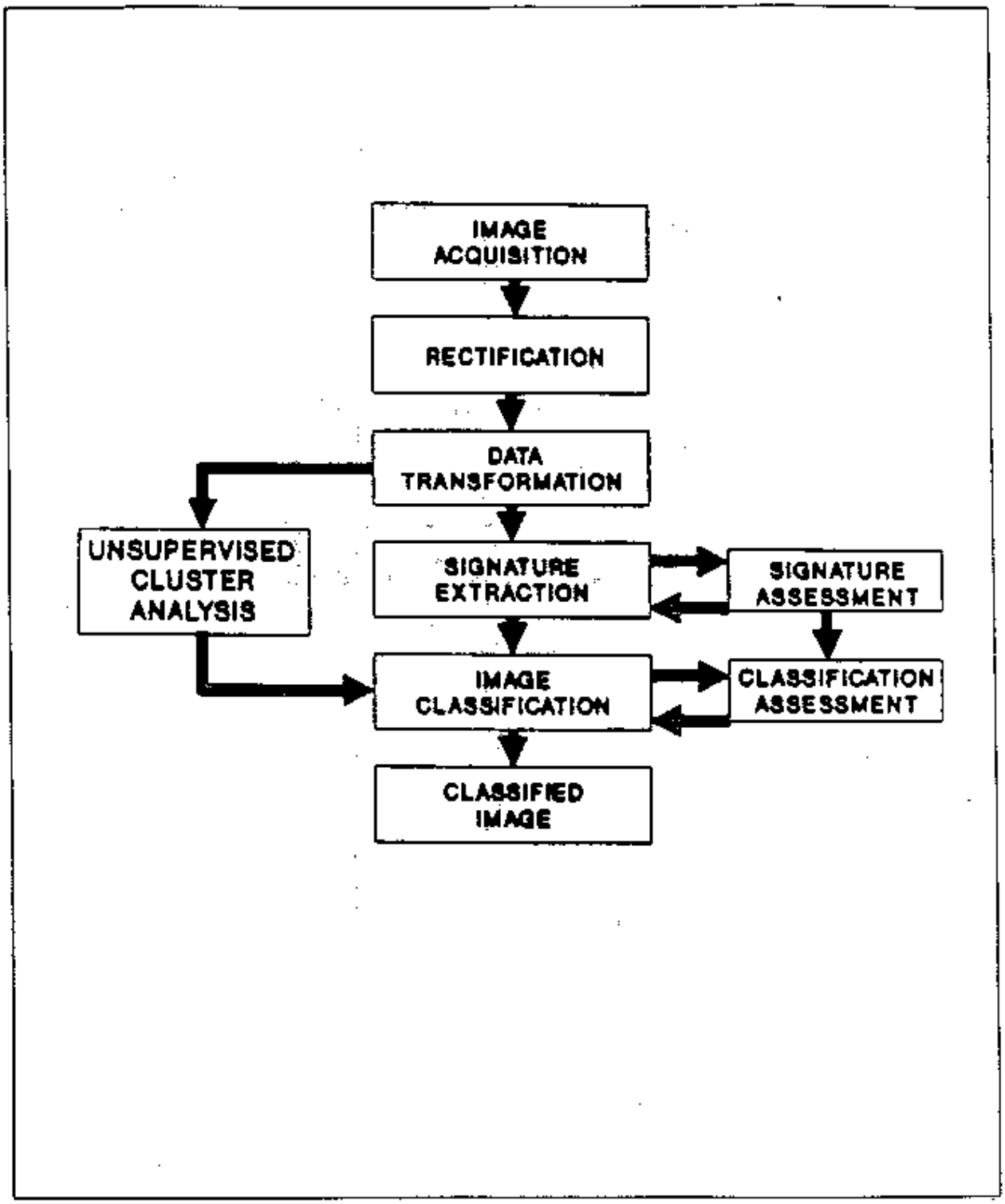


Figure 4: Basic Steps for Digital Image Analyses.

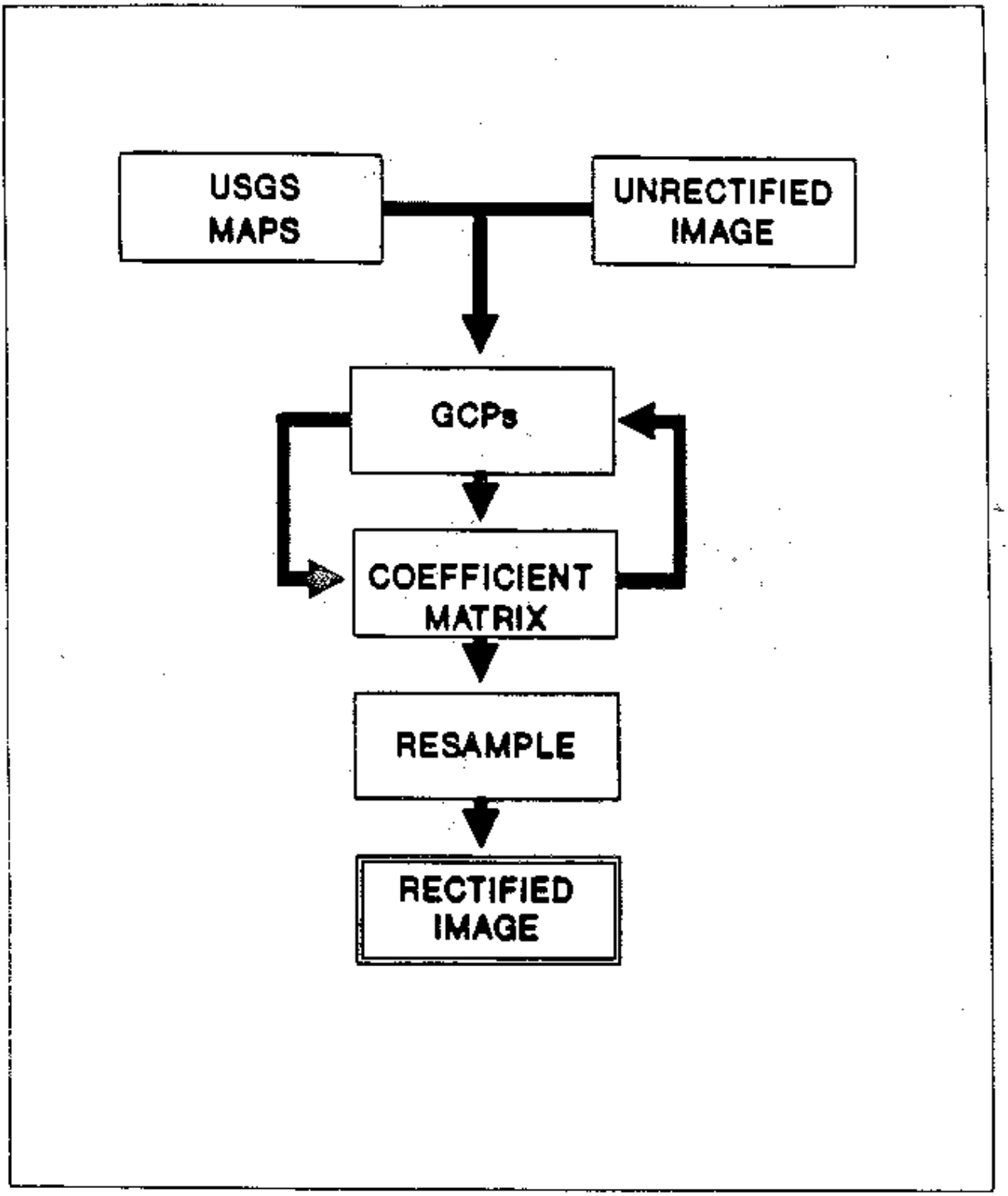


Figure 5: Basic Steps for Digital Image Rectification.

Survey (USGS) 1:24,000 scale maps from which precise coordinates (e.g., meters in northing and easting) were determined with a digitizing tablet. Second, a coefficient matrix was determined which described the geometric relationship between image pixel locations and associated map coordinates for each GCP. To achieve this, the total root mean square (RMS) of spatial error between the image locations and map coordinates was determined. The RMS attributable to each location was also calculated. GCPs contributing the greatest error were sequentially removed until the total RMS was less than or equal to 1.0. Remaining GCPs were used to calculate the final set of coefficients that model the geometric distortion of the image. These coefficients modeled six types of data distortion: translation in X and Y, scale changes in X and Y, skew, and rotation (Billingsly, 1983). The coordinate transformation coefficients were applied to every pixel in the input image in order to relocate it to its proper position in the rectified output image.

The final phase of rectification, resampling, involved the extraction of an individual pixel's value from its original location and placement of that value at the appropriate new coordinate location. Nearest Neighbor interpolation algorithm was used for all image resampling. After rectification, resulting image pixels were referenced by row and column and with respect to the UTM map projection system.

2.2.2 IMAGE CLASSIFICATION

Classification of digital satellite imagery is a means of spectral pattern recognition. Classification of the LANDSAT 2 MSS image is accomplished with a combined supervised and unsupervised classification technique. These allow extraction of signature statistics from the image based on spectral response variations within and among bands.

The first step of the classification procedure was an unsupervised classification algorithm used to extract signature statistics from the image based on spectral response variations within and among bands. The second step, supervised classification, involved the extraction of specific signatures from the MSS image. Signatures for known areas of

pasture were determined and merged with the signatures developed in the unsupervised approach.

The final classification step was the application of a supervised classification algorithm. The algorithm analyzed the digital satellite data with respect to the catalogue of combined signatures. Each pixel was compared with the signatures and was assigned to a signature with which it has the highest probability of belonging, based on statistical similarity. An output image was then generated in which every pixel from the MSS image has been assigned a particular class value.

Due to the age of the image (1976), ground truthing was impossible and therefore an accuracy assessment unavailable. However, county soils surveys which map soil series on black and white aerial photography were available. The date of the photography coincided with the satellite imagery so that a certain amount of classification assessment was undertaken. Based on these analyses, our final classification included only five landuse categories: water, forest/shrub, pasture/shrub, agriculture, and disturbed/urban.

3 RESULTS AND DISCUSSION

This section contains and briefly discusses the list of Eskimo Curlew sightings compiled as explained in section 2.1. Also discussed here are the results of landuse classification and Eskimo Curlew habitat identification.

3.1 ESKIMO CURLEW SIGHTINGS: SUMMARY LIST

A compilation of sightings within Texas of the Eskimo Curlew from the literature (and personal contacts) is provided in Table 2. The locations of these sightings are shown in Figure 6. Multiple sightings are reported to have occurred over the years at seven of these locations. As mentioned earlier, it is possible that some sightings in Table 1 and Table 2 are misidentifications. Our intentions in the compilation of this list include the desire to be as thorough and accurate as possible, but accurate only in how the list reflects the literature and personal contacts from which it came.

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas.

DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING STATUS (With TOS)	REFERENCE
1849 or 1850	Rio Grande plains in central western corner of Texas	?	A few seen	G.A. McCall	*	Oberholser, n.d.
May 4, 1860	Pecos County	Ft. Stockton	3C	P. Duffy	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Apr 23, 1868	Washington County	Long Point	1C	G. Lincecum	Accepted	Lasley, 1989; Oberholser, n.d.
Mar 17, 1876	Cooke County	Gainesville	First flock seen	G.H. Ragsdale	*	Oberholser, n.d.
Apr 8, 1876	Cooke County	Gainesville	1C	G.H. Ragsdale	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 8, 1877	Nueces County	Mouth of Nueces River near Corpus Christi	Several C; seen singly or in groups of 3 or 4	G.B. Sennett	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 15, 1877	Nueces County	Padre Island	Flocks of 20 or more seen	G.B. Sennett	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 20, 1877	Cooke County	Gainesville	Noted	G.H. Ragsdale	*	Oberholser, n.d.
Mar 30, 1877	Cooke County	Gainesville	Abundant	G.H. Ragsdale	*	Oberholser, n.d.
Oct 15, 1877	Cooke County	Gainesville	1S	G.H. Ragsdale	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 12, 1878	Cooke County	Gainesville	Seen	G.H. Ragsdale	*	Oberholser, n.d.
Apr 2, 1878	Cooke County	Gainesville	Seen	G.H. Ragsdale	*	Oberholser, n.d.
Mar 7, 1879	Cooke County	Gainesville	3 (C?)	G.H. Ragsdale?	Unsubmitted	Lasley, 1989; Oberholser, n.d.

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas (continued).

DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING-STATUS (With IDS)	REFERENCE
Mid-March, 1879	Navarro County	Rice	Abundant spring transient	J.D. Ogilby	*	Oberholser, n.d.
Mar 9, 1880	Kendall County	Boerne	15 (fairly common transient)	N.C. Brown ?	*	Oberholser, n.d.
Mid-March, 1880	Navarro County	Rice	Abundant spring transient	J.D. Ogilby	*	Oberholser, n.d.
Mar 17, 1880	Kendall County	Boerne	3C.	N.C.Brown	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 17, 1880	Cooke County	Gainesville	15	G.N. Ragsdale	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 7, 1884	Cooke County	Gainesville	Seen	G.N. Ragsdale	Unsubmitted	Oberholser, n.d.
Mar 8, 1884	Cooke County	Gainesville	Seen	G.N. Ragsdale	*	Oberholser, n.d.
Spring, 1884-1891, & at least until 1900	Bexar County	San Antonio	Flocks seen	H.P. Attwater	*	Oberholser, n.d.
Apr 1, 1884	Wise County		Observed	G.N. Ragsdale	*	Oberholser, n.d.
1884-1890	Young County	Eliasville	Rare transient	H.Y. Benedict	*	Oberholser, n.d.
Mar 7, 1885	Cooke County	Gainesville	First seen flying south	G.N. Ragsdale	*	Oberholser, n.d.
Mar 12, 1885	Cooke County	Gainesville	Seen	G.N. Ragsdale	*	Oberholser, n.d.
Mar 27, 1885	Cooke County	Gainesville	Thousands reported on high prairies by a boy	G.N. Ragsdale	*	Oberholser, n.d.

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas (continued).

DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING STATUS (With TOS)	REFERENCE
Mar 30, 1886	Cooke County	Gainesville	Small flocks seen flying in a sleet storm	G.H. Ragsdale	*	Oberholser, n.d.
1886	Calhoun County		Small flocks observed	J.D. Mitchell	*	Oberholser, n.d.
Mar 24, 1887	Cooke County	Gainesville	First one seen	G.H. Ragsdale	*	Oberholser, n.d.
Mar 25, 1888	Cooke County	Gainesville	Seen	W. Kraig	*	Oberholser, n.d.
Mar 22-28, 1889	Cameron County	Brownsville	1 (S or C?)	?	Unsubmitted	Lasley, 1989
Mar 26, 1889	Cooke County	Gainesville	First heard	G.H. Ragsdale	*	Oberholser, n.d.
Mar 27, 1889	Cooke County	?	1 (S or C?)	?	Unsubmitted	Lasley, 1989
Mar 27, 1889	Cooke County	Gainesville	12S	G.H. Ragsdale	*	Oberholser, n.d.
Apr 2, 1889	Cameron County	Brownsville	1C	Fields & Armstrong	Unsubmitted	Lasley, 1989; Oberholser, n.d.
Mar 28, 1890	Cameron County	Brownsville	1 (S or C?)	F. Armstrong	Unsubmitted	Lasley, 1989
Apr 2, 1890	Cameron County	Brownsville	1 (S or C?)	F. Armstrong	Unsubmitted	Lasley, 1989
1890	Lampasas County	Lampasas(?)	Flocks of 15 or 20S; 1C	A.S. Eldredge	Unsubmitted	Lasley, 1989; Oberholser, n.d.
1894		Clarksville	Observed	W.O. Posey	*	Oberholser, n.d.
Mar, 1897	Cameron County	Brownsville	1 (S or C?)	?	Unsubmitted	Lasley, 1989

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas (continued).

DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING STATUS (With TOS)	REFERENCE
1905	Victoria County		3S	J.D. Mitchell	*	Oberholser, n.d.
Apr 29, 1945	Galveston Island	Curlew field	2S	Heiser, Miner, & Kaiser	Unsubmitted	Gollop et al., 1976:15; Heiser, 1945; Lasley, 1989
Apr 27-29, 1950	Rockport	One mile south of Rockport	1S	Hagar & Snyder	Unsubmitted. In doubt: See Corrigenda on p.686 of Auk, vol. 82, Oct. 1965	Weston and Williams, 1965
Mar 22, Apr 18 & 26, 1956	Galveston Island	?	1S	?	Unsubmitted. In doubt (Gollop, Barry, and Iversen 1986:15)	Iversen, 1976; Lasley, 1989
Mar 22, 1959	Galveston Island	Curlew field	1S	Feltner & Deaver	Unsubmitted	Lasley, 1989; Williams, 1959; Emanuel, 1962
Apr 5, 1959	Galveston Island	Curlew field	1S	Feltner, Deaver, Emanuel, & Fowler	Unsubmitted	Lasley, 1989; Williams, 1959; Emanuel, 1962
Apr 8, 1959	Galveston Island	Curlew field	1S	Emanuel	Unsubmitted	Lasley, 1989; Williams, 1959; Emanuel, 1962
Apr 10, 1959	Galveston Island	Curlew field	1S	Emanuel & G.G. Williams	Unsubmitted	Lasley, 1989; Williams, 1959; Emanuel, 1962

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas (continued).

DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING STATUS (With TOS)	REFERENCE
Apr 12, 1959	Galveston Island	Curlew field	1S	Edwards, Emanuel, & Fowler	Unsubmitted	Lasley, 1989; Williams, 1959; Emanuel, 1962
Apr 26, 1959	Galveston Island	Curlew field	1S	Yramategui	Unsubmitted	Lasley, 1989; Williams, 1959; Emanuel, 1962
Apr 3, 1960 (4pm)	Galveston Island	Curlew field	1S	Aiken, S.G. Williams, & Emanuel	Unsubmitted	Emanuel, 1961, 1962; Lasley, 1989
Apr 3, 1960 (Later)	Galveston Island	Curlew field	1S	Strickling, Hoffman, Aiken, S.G. Williams, & Emanuel	Unsubmitted	Emanuel, 1961, 1962; Lasley, 1989
Apr 4, 1960	Galveston Island	Curlew field	1S	Yramategui	Unsubmitted	Emanuel, 1961, 1962; Lasley, 1989
Apr 6, 1960	Galveston Island	Curlew field	1S	Snyder & Snyder	Unsubmitted	Emanuel, 1961, 1962; Lasley, 1989
Mar 31, 1961	Galveston Island	Curlew field	1S	Patten	Unsubmitted	Emanuel, 1962; Lasley, 1989
Apr 1, 1961	Galveston Island	Curlew field	1S	Lowery, Jeter, Stewart, & Strickling; PHOTO BY - C. McINTYRE	Unsubmitted	Emanuel, 1962; Lasley, 1989
Apr 3, 1961	Galveston Island	Curlew field	1S	Emanuel, Aiken, & Yramategui	Unsubmitted	Emanuel, 1962; Lasley, 1989

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas (continued).

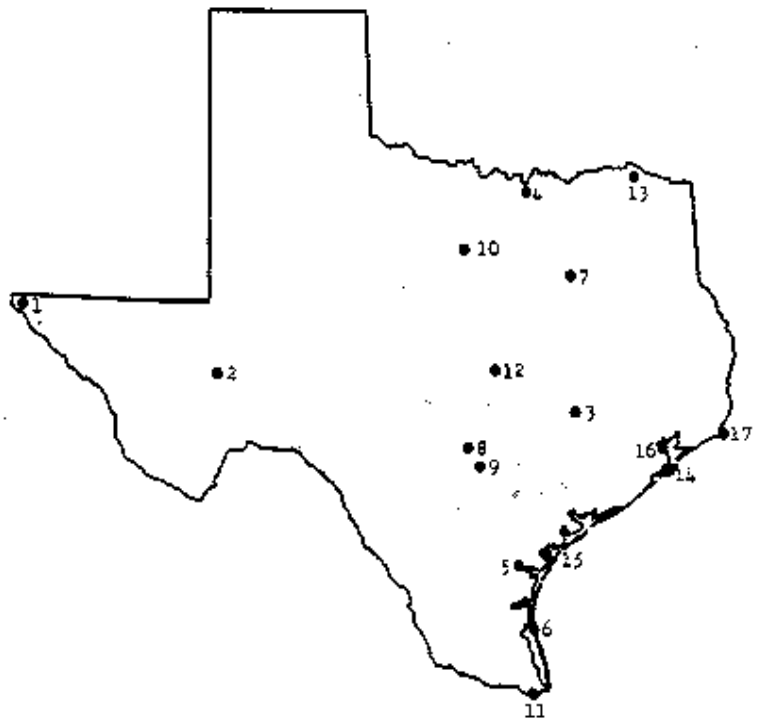
DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING STATUS (With TOS)	REFERENCE
Mar 24-Apr 3, 1962	Galveston Island	Curlew field	3 or 4S	Lowery; PHOTO BY BLEITZ	Accepted (but number in question)	Gollop et al., 1986:15,95; Lasley, 1989; Weston & Williams, 1965
Mar 24-Apr 3, 1962	Galveston Island	Curlew field	2S	Strickling & Deshayes; PHOTO BY BLEITZ	Accepted (but number in question)	Emanuel, 1962; Gollop et al., 1986:15,95; Lasley, 1989 1986:15,95;
Apr 11-12, 1963	Rockport	One mile south of Rockport	1S	"A number of observers"	Unsubmitted	Lasley, 1989; Webster, 1963; Weston & Williams, 1965
Mar 29, 1964	Galveston Island	Curlew field	2S	Deshayes & Strickling	Unsubmitted	Lasley, 1989; Webster, 1964
Apr 30, 1968	Rockport	Canoe Lake	1S	Lieftink	Unsubmitted	Lasley, 1989; Lieftink, 1968
Jan 21, 1972	Texas	?	1S	?	Unsubmitted(?)	Lahrman, 1972
May 7, 1981	Galveston Bay	Atkinson Island	23S	Blankinship & King	Unaccepted	Blankinship & King, 1984; Lasley, 1989
Mar 11 1984	Bexar County	San Antonio	1S as a fly-by in a storm	Willie Sekula	Unsubmitted	Lasley & Sexton, 1984; Lasley, personal communication by phone, 1-9-91
Mar 31, 1985	Galveston County	Galveston Island	1S	David Marrack	Unsubmitted	Lasley & Sexton, 1985
Apr 17, 1987	Jefferson County	Sabine Pass	1S	?	Unsubmitted	Lasley, 1989
May 2, 1987	Aransas County	Blackjack Point	3S	?	Unaccepted	Lasley, 1989

Table 2: Summary List of Reported Sightings of Eskimo Curlews in Texas (continued).

DATE	GENERAL LOCATION	SPECIFIC LOCATION	NUMBER INVOLVED	OBSERVER/ COLLECTOR/ REPORTER	SIGHTING STATUS (With TOS)	REFERENCE
Apr 20, 1990	Corpus Christi	Flower Bluff	1S	Dwayne Chapman	*	Craig Faanes, US Fish & Wildlife, personal communication by phone, 4-27-90

C=Collected
S=Sighted

* Status Not Categorized by TOS (Texas Ornithological Society). See Part 3.1 and Lasley, 1989.



Number	Location	Year of First Reported Sighting
1	Rio Grande Plains	1849
2	Ft. Stockton	1860
3	Long Point	1868
4*	Gainesville	1876
5	Mouth of Nueces River Near Corpus Christi	1877
6	Padre Island	1877
7*	Rice	1879
8*	Boerne	1880
9*	San Antonio	1884
10	Eliasville	1884
11*	Brownsville	1889
12	Lampasas	1890
13	Clarksville	1894
14*	Galveston Island (Curlew Field)	1945
15*	Rockport (One mile south)	1950
16	Galveston Bay (Atkinson Island)	1981
17	Sabine Pass	1987

* Indicates Location with More Than One Sighting in Table 2

Figure 6: Locations of Reported Eskimo Curlew Sightings in Texas

Some additional discussion of our list of sightings is needed for the sake of clarity. Blanks and question marks in a column indicate that specific information is not available or is unclear. In the "SPECIFIC LOCATION" column, "Curlew field" means either the field on Galveston Island where Eskimo Curlews are reported to have been consistently seen in the past (Williams, 1962), or one of the fields in close proximity to it. The "C" and "S" in the "NUMBER INVOLVED" column mean captured and sighted, respectively, reflecting literature descriptions. So, for example, "1C" means that one Eskimo Curlew is reported to have been captured at the time and place given. This column also contains some explanatory phrases taken from the associated reference, possibly abbreviated, but with their gist maintained.

Pertaining to the "SIGHTING STATUS" column, the following definitions of status categories are from Lasley (1989). An asterisk (*) indicates that we have no knowledge of the record in question belonging to any of these three categories.

ACCEPTED: "A record is considered accepted if a specimen has been obtained, a recognizable photo has been submitted to the TPRF" (Texas Photo Record File) "and TBRC" (Texas Bird Records Committee), "or a written description of a sighting has been judged acceptable by the TBRC. For each accepted record a TPRF or TBRC file number will be included as a reference, and for specimen records the location and museum number of the specimen is included where known. Note that on many records reviewed prior to 1988 only a TPRF number is given. Beginning in 1988 all records of Review Species including photographed or specimen records must be reviewed by the TBRC as well."

UNACCEPTED: "A record is considered rejected if the TBRC has judged it unacceptable by questioning the identification, the origin, or the viable status of the population. It is important to understand that in rejecting a record the TBRC is not trying to say that the bird was not seen. A number of factors may contribute to a record being denied acceptance. It is rather uncommon for a record to be rejected because the bird was obviously misidentified. More often, a record may be denied acceptance because the

information provided was not sufficient to document the reported occurrence. It is very difficult to provide the TBRC with too much detail on a record; it is all too easy, however, to not take enough time to describe a bird well and eliminate all similar species. The TBRC file number will be included on all rejected records. The TBRC will be happy to reconsider a rejected record if more information can be supplied."

UNSUBMITTED: "These are reports of the species that have appeared in print, (or, in a few cases, supplied from individuals) but written or photo documentation has not been reviewed by the TBRC. The TBRC solicits any information regarding any of the unsubmitted reports. In cases where the 1984 TOS Checklist reports a specimen cannot be located (s.n.l.) that record is considered 'unsubmitted' for the purposes of this document."

3.2 SATELLITE IMAGERY/ESKIMO CURLEW SIGHTING ANALYSES

One of the original goals of this research project was to develop a spatial model based on satellite imagery which would allow us to predict where potential eskimo curlew habitat still occurs. Thus, an initial step in the project was to acquire historical satellite imagery, classify it, and then determine the spatial characteristics of the locations of where Eskimo Curlew's had been sighted. Based on consultation with Texas Parks and Wildlife, a costal satellite image containing Galveston Island was selected as an appropriate image, since, at a minimum, Galveston Island has been the location of numerous Eskimo Curlew sightings. Since a satellite image covers nearly 8 million acres, it seemed reasonable to assume that several Eskimo Curlew sighting locations would be contained in the image.

The image selected was recorded on the first day of February in 1976, and the Texas coast approximately bisects the image from the southwest corner of the image to the northeast corner of the image. Thus, water (the Gulf) occupies 48.2% of the image (3.8 million acres). Pasture/shrub lands occupies the next largest category of landuse (25.5% or just over 2 million acres). However, if the Gulf is removed from analyses,

pasture/shrub dominates this image with 49.2% of the land surface. Next, agriculture lands occupied just under 1 million acres in February of 1976 or 24.1% of the land surface. Close behind agriculture in terms of spatial extent was forest/shrub lands at just over 3/4 of a million acres (18.7%). Finally, disturbed/urban lands occupied approximately 1/3 of a million acres of the land surface (8.0%). Figure 7 represents a final classified image of the study area. A legend showing which color represents which landuse for this figure is shown in Figure 8.

Unfortunately, the only area in the entire image selected for use with this project which has had Eskimo Curlews sighted is the "Eskimo Curlew Field" mentioned earlier. This area is shown in Figure 9 (see previously displayed Figure 7 for legend); bordered by Stewart Road to the north, the beach to the south, 7 Mile Road to the east, and 7.5 Mile Road to the west. Since there is only one relatively small area within the image where Eskimo Curlews have been sighted, it is impossible to build a spatial model to predict where Eskimo Curlew habitat still occurs. Never-the-less, the literature can provide a glimpse of the potential habitat that Eskimo Curlew's utilize in Texas. Table 3 represents verbal descriptions in the literature which indicate these habitat types. Notice that by-in-large, the descriptions indicate grassy areas, near open or marshy waters.

In conclusion, it seems that the Eskimo Curlew is an extraordinarily rare bird today. Its habitat, based on descriptions from the literature, comprise grassy areas or beaches near open or marshy waters. Habitat destruction alone must not account for the demise of the Eskimo Curlew from the flocks of thousands seen in the late 1800's to the rare sightings of one or two birds at a time seen most recently, since there is ample grassy areas near water remaining in Texas. In fact, in the single image analyzed for this project, which represents an area ranging from no more than 70 miles from the Gulf, to the shores of the Gulf, pasture/shrub lands represent the single largest land cover type (2 million acres or nearly 50% of the land in the image). Something other than habitat destruction must be to blame.

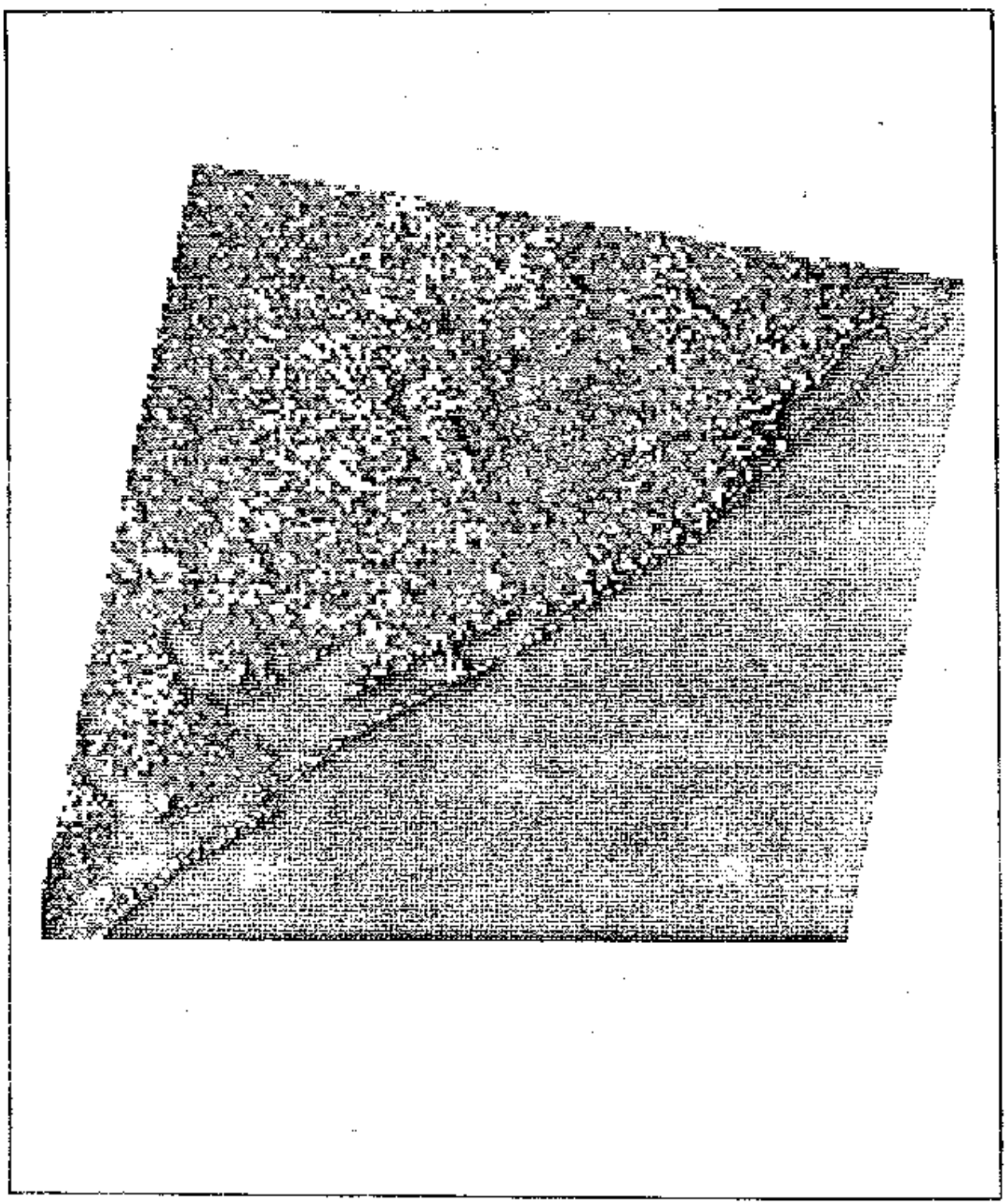


Figure 7: LANDSAT 2 MSS Classified Image of the Study Area.

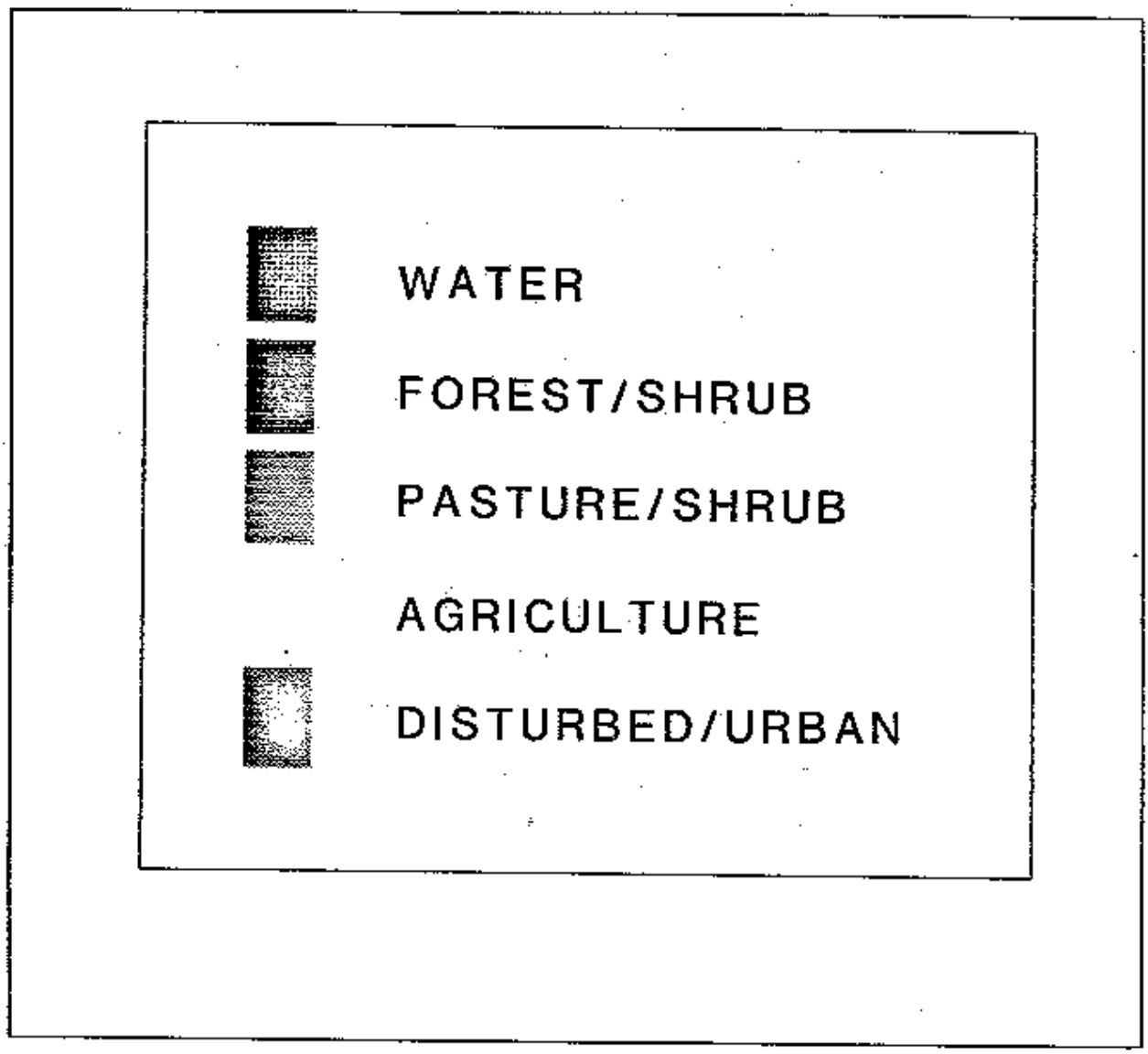


Figure 8: Legend of Classification Scheme.

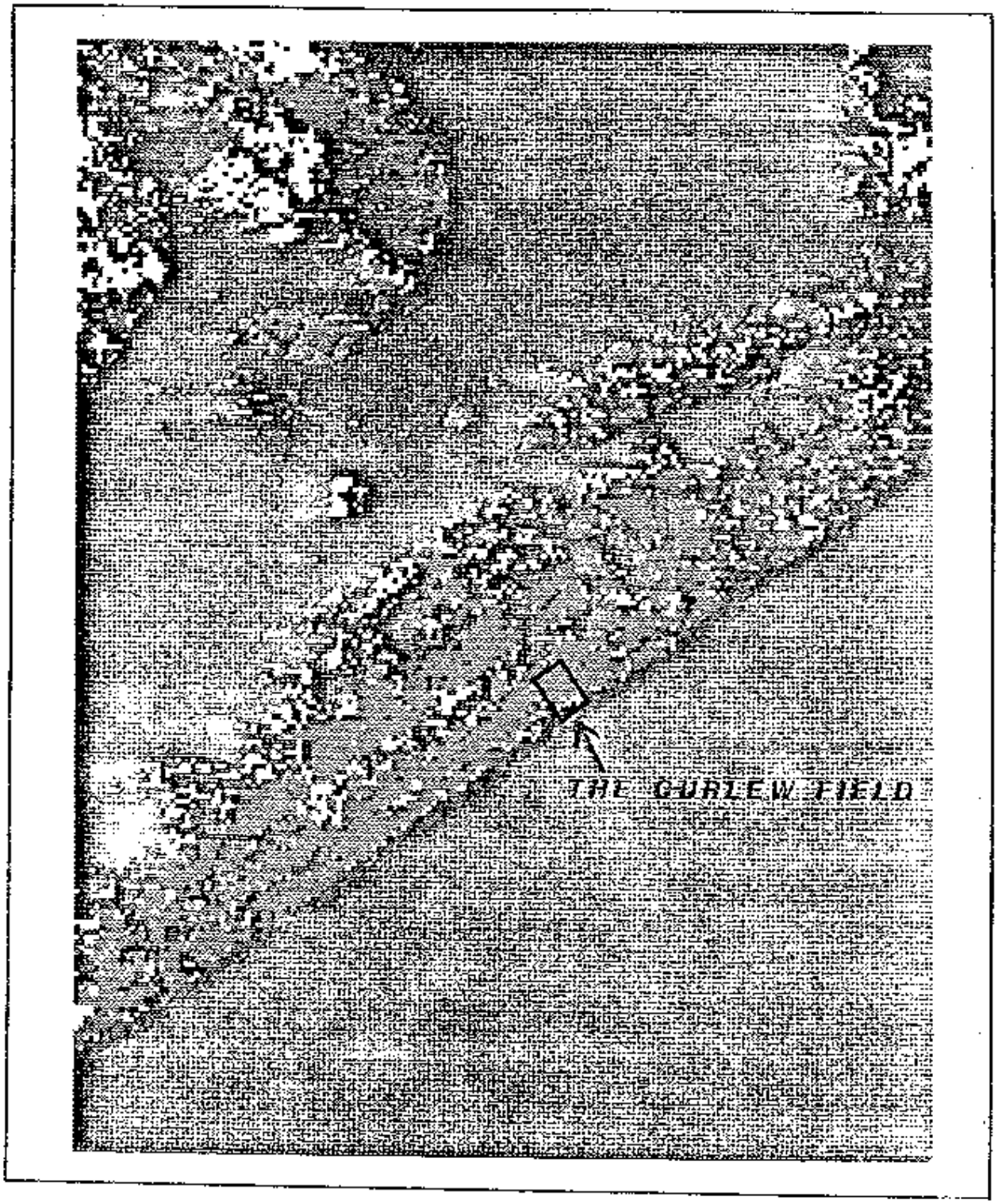


Figure 9: LANDSAT 2 MSS Classified Image of the Galveston Island Curlew Field.

Table 3: Literature Descriptions of Eskimo Curlew Habitat

Description of Land Use	Reference
Open.	Gollop, et al., 1986
Grassy barren ground, low hills, partly barren.	"
Mud flats, sandbars, within a few kilometers of the sea.	"
Old fields and closely grazed pastures.	"
Broad dry or marshy pampas.	"
Burned-over prairies and marshes.	"
Following the plough in wheat and corn fields.	"
Beaches.	"
Around shallow ponds, grassy patches and sand flats.	Heiser, 1945
Well-drained, gently-rolling pasture (grazed) with grass about 3-4 inches high.	Williams, 1959
Plains and prairies.	Oberholser, n.d.

4 APPENDICES

4.1 APPENDIX A

LANDUSE CLASSIFICATION STATISTICS

Header listing for GIS file: RCFINP.GIS
Date statistics printed: 24-JAN-1991
Date statistics created: 24-JAN-1991

This file has 2263 rows, and 2753 columns

This image is geo-referenced to a UTM coordinate system
The upper left corner has coordinate: 698521, 3288100

The cell size is (X, Y): 80, 80
The number of acres per cell is: 1.581526
Upper left corner data file coordinate (X,Y) is: 1, 1

Number of classes in this variable is: 6
This file contains 4-bit data
The VARIABLE name is Classified 1976 MSS Imagery

VALUE	POINTS	ACRES	%	DESCRIPTION
0	1238434	1958615.6	0.00	OUTSIDE AREA
1	2406247	3805542.3	48.21	WATER
2	483928	765344.8	9.69	FOREST/SHRB
3	1271963	2011642.6	25.48	PASTURE/SHRB
4	623181	98557.0	12.48	AGRICULTURE
5	206286	326246.7	4.13	DISTURBD/URB
Totals:	4991605	7894353.5		

Totals and Percentages are Based on Non-zero points

4.2 APPENDIX B

SOURCES OF INFORMATION

NAME	ORGANIZATION	PHONE NUMBER
Angle, Phil	Smithsonian Institution	(202)357-2031
Arnold, Keith	Texas A&M University	(409)845-5777
Austin, Mike	Texas Rare Bird Alert	(713)821-2846
Baumgardner, George	Texas A&M University	(409)845-5777
Emanuel, Victor	Victor Emanuel Nature Tours	(512)328-5221
Eubanks, Ted	Texas Ornithological Society	(713)747-0101
Faanes, Craig	U.S. Fish & Wildlife Service	(308)381-5571
Greene, Casey	Rosenberg Library, Galveston	(409)763-8854
Lasley, Greg	Texas Ornithological Society	(512)441-9686
Lewis, Jim	U.S. Fish & Wildlife Service	(505)766-3972
McDonald, Darrel	Stephen F. Austin State University	(409)568-6605
Oliver, Karl	Smithsonian Institution	(202)357-2031
Petite, David	U.S. Army Corps of Engineers	(409)766-3032
Sexton, Chuck	City of Austin	(512)499-2694
Sloss, Richard	American Museum of Natural History	(212)769-5000

4.3 APPENDIX C

TBRC REQUEST FOR INFORMATION

Many records of Eskimo Curlew sightings in the TBRC "UNSUBMITTED" category have had written documentation submitted to various committees and organizations. The TBRC needs help in obtaining such documentation for review. If you have any information concerning any unsubmitted records, or any record of a review species not listed by the TBRC, please contact:

Greg Lasley
Secretary, TBRC
305 Loganberry Ct.
Austin, TX 78745-6527
(512) 441-9686.

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