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REMOTE SENSING AS AN AID FOR MARSH MANAGEMENT

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Each report in this series describes action taken to solve a particular problem, or to understand natural phenomena affecting the solution of a problem. Recommendations are offered to the interested agency. Remedial action and/or the adoption of techniques used are encouraged.

REMOTE SENSING AS AN AID FOR MARSH MANAGEMENT

by

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REMOTE SENSING AS AN AID FOR MARSH MANAGEMENT

James G. Ragan and John Green*

SYNOPSIS

NASA aerial photography, primarily color infrared and color positive transparencies, is used in a study of marsh management practices and in comparing managed and unmanaged marsh areas. Weir locations for tidal control are recommended.

INTRODUCTION

The main objective of this study was to explore the feasibility of using remote sensing techniques in monitoring and evaluating selected areas of Louisiana's coastal marshes. Remote sensing data were collected by the National Aeronautics and Space Administration and consisted of color infrared transparencies obtained in flights occurring in May, June and September of 1973.

Remote sensing, i.e. aerial photography, was first employed in World War II where it was used for military surveillance. More recently remote sensing has taken on added dimensions where it is being developed for engineering and environmental assessment projects.

In the Gulf coast it has been utilized in locating breeding habitats of mosquitoes in southern Mississippi (1), and more recently as an aid for evaluating designated routes for the relocation of Louisiana highway 1 in Lafourche Parish, Louisiana (2).

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During the summer of 1973 Louisiana State University and Nicholls State University personnel attempted to demonstrate the usefulness of remote sensing techniques in the management of Louisiana's marshes.

Louisiana's marshes and their associated bodies of water are influenced by local tides. This variation, if extreme, can reduce the production of wildlife and aquatic fauna, especially if the marsh has been disturbed by channelization.

With proper management techniques Louisiana's marshes can be improved by providing stable habitats for desirable vegetative associations and their associated fauna. Such management includes (1) increasing the production of resident species and (2) increasing the desirability of the marsh for migratory species.

These objectives can be attained through habitat improvement whereby food production is increased by creating a proper balance between marsh and associated bodies of water. Currently, attainment of these objectives is through the strategic placement of water control structures called weirs. In theory a weir, if properly placed, improves the marsh by (1) reducting extreme water level fluctuation (2) reducing the rate of tidal exchange, (3) reducting sudden and severe changes in salinity, (4) lowering turbidity, and (5) improving resident vascular flora by modifying the marsh behind the weir.

MATERIALS AND METHODS

Aerial photography was supplied by NASA through Johnson Spaceflight Center, Houston, Texas, the Earth Resources Laboratory, at the Mississippi Test Facility. Interpretation was made by personnel from Nicholls State University.

Ground truth data were obtained during the months of June, July and August and consisted of identifying vegetation at selected sites, profiles of waterways, tidal exchange rates, and the quantitative collection of nekton, benthic and zooplankton organisms. Soil analyses were a part of the overall erosion and sediment study perfomed by Dr. Self (7). Those parts of his study related to the Pointe au Chien area are included in this report.

Nekton was collected employing 10 minute tows with a 16' otter trawl. The benthic invertebrates were collected using an Ekman dredge. Zooplankton was sampled with a 30 cm #10 plankton net fitted with a flowmeter to determine the volume of water strained during a 2 minute tow.

Channel profiles were measured using a 100' engineering tape and a 2-meter rod.

Water volume flow was measured using a flowmeter.

In the Pointe au Chien region, 19 sediment samples were taken from marshes, spoil banks and channel in a managed area (Louisiana Land and Exploration Company Camp) and on nearly unmanaged land. The sediment samples were analyzed for texture using a soil hydrometer and for chemistry using a LaMotte Soil Analysis kit.

DESCRIPTION OF SITES

Sites studied are located in Terrebonne Parish south of Houma, Louisiana in an area commonly referred to by local residents as a Pointe au Chien area (see Figure 1). This region of Terrebonne Parish is a popular hunting, trapping and fishing region. The marsh is dissected by numerous oil and gas pipeline canals attesting to the extensive mineral extraction activities occurring in the area. These canals provide desirable

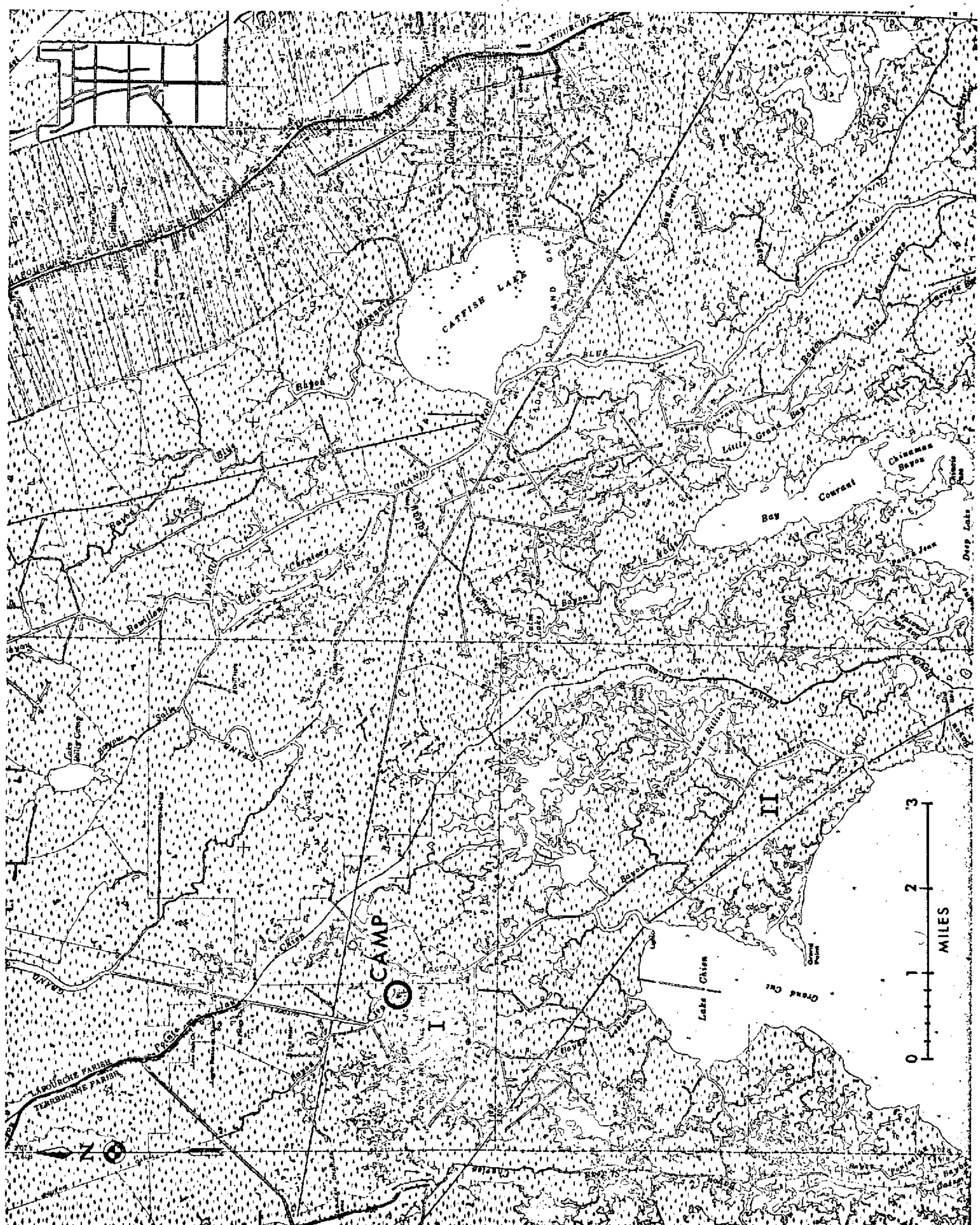

FIGURE 1 -- Sites Studied: Pointe au Chien area, Terrebonne Parish Louisiana

habitats for the resident and migratory fishes and shellfishes of the area. Within this region two sites were selected for study.

Site 1: Louisiana Land and Exploration Camp. This site is located on Bayou Jean Lacroix, approximately two miles south of Hebert's Landing (Figure 2). Selection of the site was made because this area has been impounded and managed for some time. Tidal exchange for the entire site occurs through a single weir located on Bayou Jean Lacroix (Figures 2 and 3). Color IR photographs of the two sites are included in the attached folder. Identification of certain characteristics are given on the backside of each photo.

Site 1, Vegetation: The site is difficult to classify under current marsh vegetation classification schemes currently employed. The dominant vegetation of the marsh proper included wiregrass (Spartina patens), leafy three-corner grass (Scirpus robustus), saltgrass (Distichlis spicata) and widegeon grass (Ruppia maritima). Other dominant species included duckweek (Lemma minor), wild millet (Echinochloa walteri), spike rush (Eleocharis parvula), coontail (Ceratophyllum demersum) and cutgrass (Zizaniopsis sp.). The vegetation of the levees surrounding the marsh is complex and are dominated by woody shrubs of baccharis (Baccharis haliminfolia) and marsh elder (Iva frutescens), while herbaceous plants include burmudgrass (Bynodon dactylon), goldenrod (Solidago sp.), Vasey grass (Paspulum urvillei), pokeweek (Phytolacca americana), sow thistle (Sonchus sp.), dog fennel (Eupatorium capillifolium), dayflower (Commelina communis), wild lettuce (Lactuca scariole),morning glory (Ipomea sp.), broomsedge (Andropogon virginicus) and numerous composites.

Because this area is leveed and managed it cannot be classified as a natural marsh. Vegetation associations endemic to the site are typical of brackish, intermediate and freshwater marshes. Since water

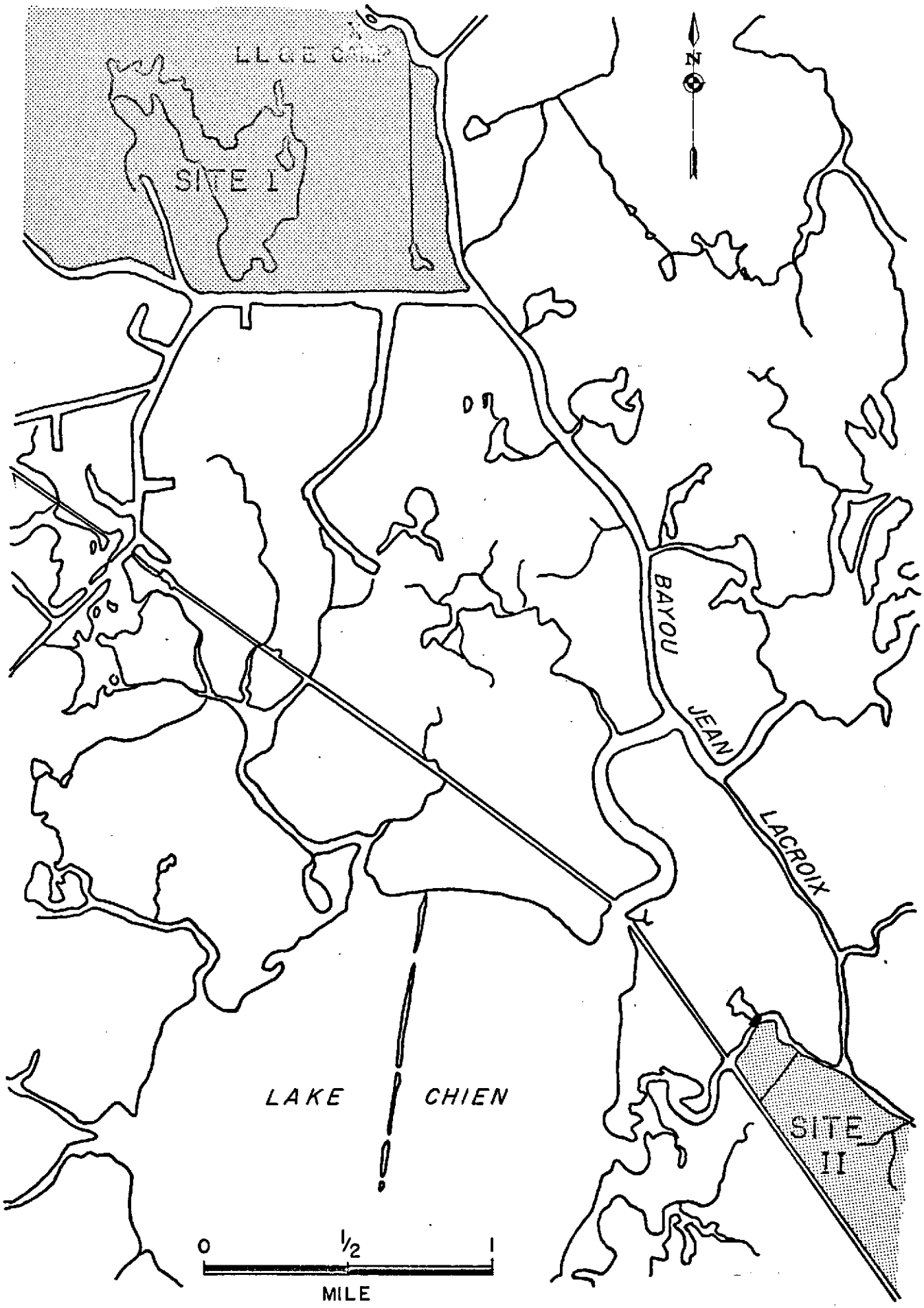

FIG. 2 LOCATION OF RESEARCH SITES

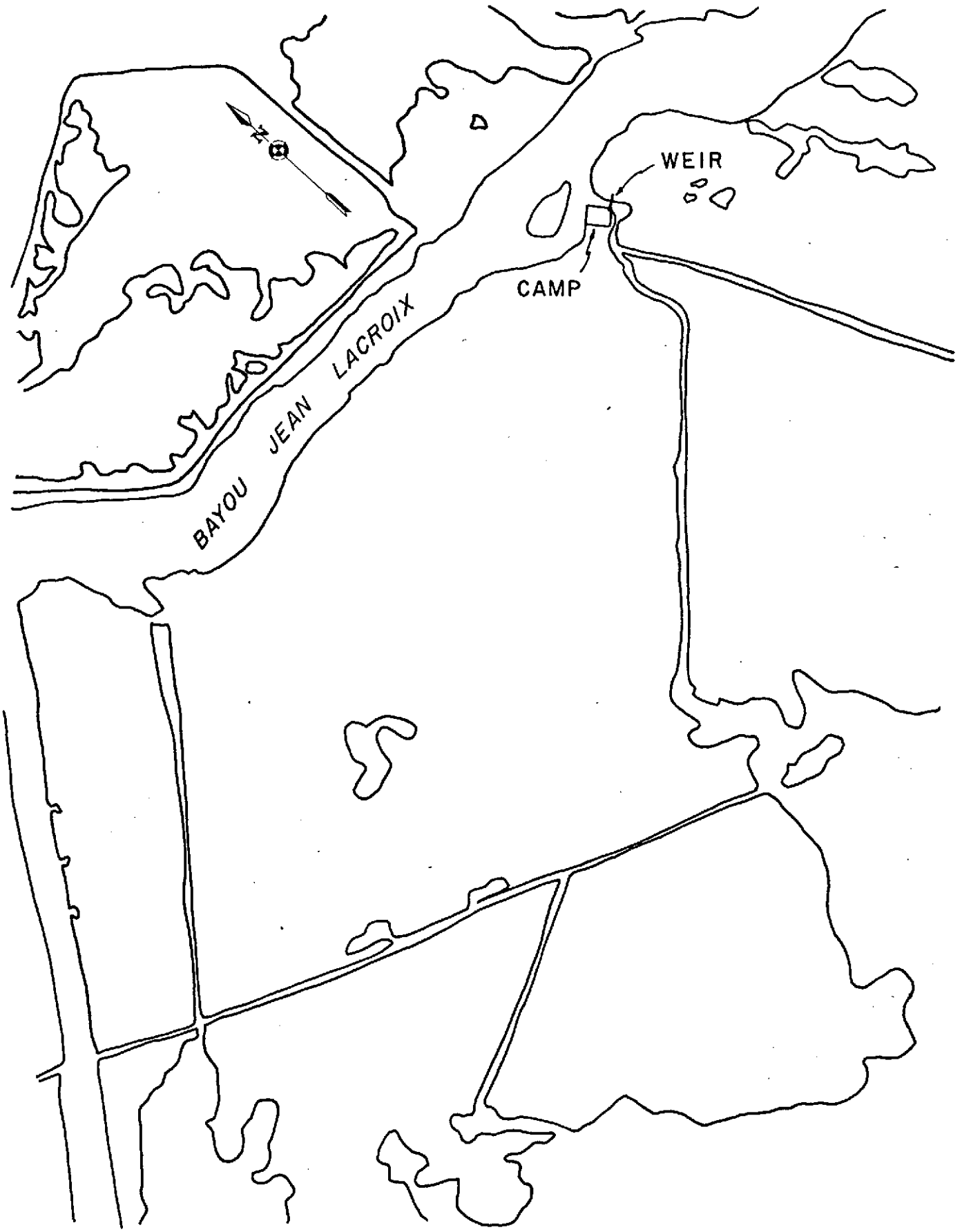

FIG. 3 SITE I; LOCATION OF LL&E CAMP AND WEIR

exchange is controlled by the weir located on Bayou Jean Lacroix the salinity within the impounded area can be controlled; thus regulation of the vegetative associations and their accompanying fauna is possible (3).

Site 2: This site was chosen primarily by reviewing imagery obtained during the May and June flights and reviewed by Nicholls State University personnel during July of 1973. Prior to reviewing this imagery other sites were explored but these were not captured during the May and June flights. This particular location is on property owned by the La Terre Corporation.

The site is located on Bayou Jean Lacroix, approximately 2-1/2 miles south of Site 1 (Figures 2 and 4). The area is bounded on the north, east, and south by Bayou Jean Lacroix and its tributaries; on the west by a bulk-headed pipe line canal. The site should not be considered a natural marsh by current definitions in light of the mineral extraction activities, as evident by the pipeline canal bordering the west boundary of the area, and by the location of the weir at the extreme south end of the area on Bayou Jean Lacroix (Figure 4). However, this marsh is typical for this region.

Site II, Vegetation: The vegetation of the marsh proper is indicative of a brackish marsh. Dominate sepcies included wiregrass (Spactina patens), saltgrass (Distichlis spicata), oystergrass (Spartina alterniflora) and scattered patches of black rush (Juncus roemerianus).

The sediment samples from the Point au Chien area were analyzed for chemical composition, texture, water content which are shown in Table I. Maps showing sample locations in the managed and unmanaged areas are shown in Figures 5 and 6.

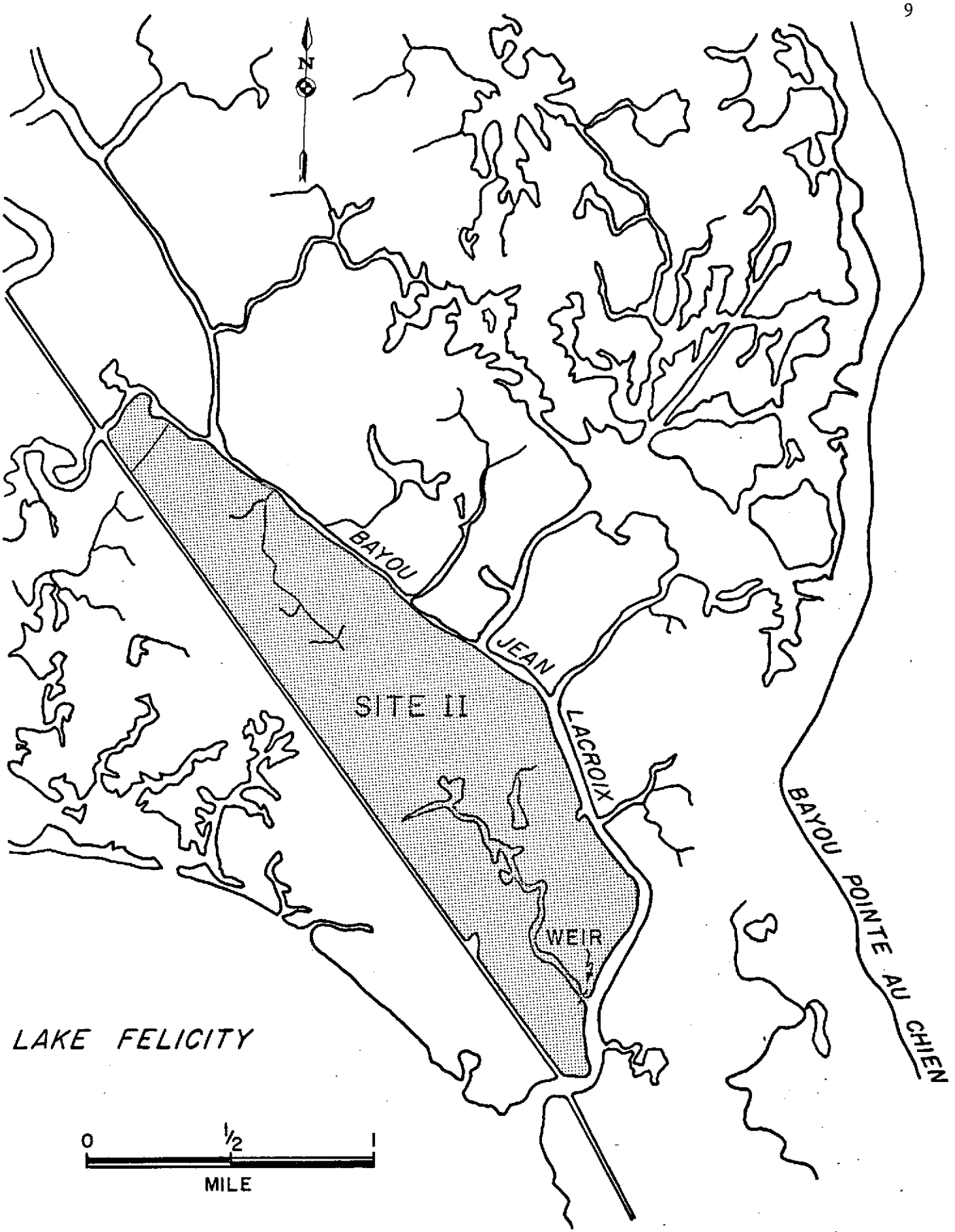

FIG. 4 LOCATION OF SITE II

TABLE I

COMPARISON OF SAMPLES

	Fourchon Spoil Bank	Fourchon Marsh	Fourchon Btm. Smpl.	Fourchon Beach	Pointe au Chien Mgd. Marsh	Pointe au Chien Un-Mgd.Mrsh	Pointe au Chien Spoil Bank	Pointe au Chien Btm. Smpl.	Lake Boeuf Marsh	Lake Boeuf Btm. Smpl.	Lake Boeuf Spoil Bank
pH	6.5-7.5	>8.0	>8.0	>8.0	7.6-7.8	7.6-8.0	6.8	8.0	6.4-6.8	6.4-6.8	6.4-6.8
Soil Moist	30-40%	50-70%	50-70%	10-20%	70-80%	70-80%	35-60%	60-80%	50-80%	60-78%	26%
Al	100-200 ppm	>200 ppm	>200 ppm	0-25 ppm	5-100 ppm	40-200 ppm	10-40 ppm	>200 ppm	5-200 ppm	100-200 ppm	5 ppm
K	300-400 lb/acre	300-400 lb/acre	300-400 lb/acre	200-300 lb/acre	100 lb/acre	180 lb/acre	130-190 lb/acre	200 lb/acre	120-160 lb/acre	115-130 lb/acre	130 ppm
Fe^{3+}	25-50 ppm	<2 ppm	25-50 ppm	<2 ppm	<2 ppm	<2 ppm	<2 ppm	<2 ppm	10-100 ppm	25-50 ppm	2 ppm
Ca	1200 ppm	350-700 ppm	350-700 ppm	750-1000 ppm	150 ppm	150-350 ppm	150 ppm	150 ppm	150-700 ppm	350-700 ppm	350 ppm
Mg	20-80	40-80 ppm	0-20 ppm	100 ppm	40-80 ppm	80 ppm	80 ppm	160 ppm	20-80 ppm	80 ppm	20 ppm
Mg	10-40 ppm	T	T	10-20 ppm	T	T	T	T	T-12 ppm	T-25 ppm	T
Cl	2000-2400 ppm	2500-3000 ppm	2500-3000 ppm	2500-3000 ppm	500 ppm	500 ppm	50-500 ppm	500 ppm	T	T	T
PO_4	100-150	200 ppm	150 ppm	0-50 lb/acre	100 lb/acre	200 lb/acre	50-200 lb/ac	200 lb/acre	100-150 lb/ac	150-200 lb/ac	150 lb/acre
SO_4	150-200 ppm	0-50 ppm	0-50 ppm	100-150 ppm	50 ppm	50 ppm	50 ppm	50 ppm	T	T-50 ppm	T
Nitrate	10 lb/acre	20-40 lb/ac	20 lb/acre	10 lb/acre	10 lb/acre	10 lb/acre	10 lb/acre	10 lb/acre	20 lb/acre	10-20 lb/ac	20 lb/acre
Nitrite	T - 1 ppm	T - 1 ppm	T - 1 ppm	T - 1 ppm	T	T	T	T	T	T - 1 ppm	T
Texture Sediment Class	Sdy-Silt to Silty sd.	Mud, Silty mud Silty sdy mud	Sandy silt	Sand	Silt to mud	Silt to Sandy Silt	Silty-sdy mud-sdy silt some clay & sand	Sandy Silt	Mud to Silt	Mud, silty-sdy-mud, sdy-silt-mud, sdy-silt	Sandy

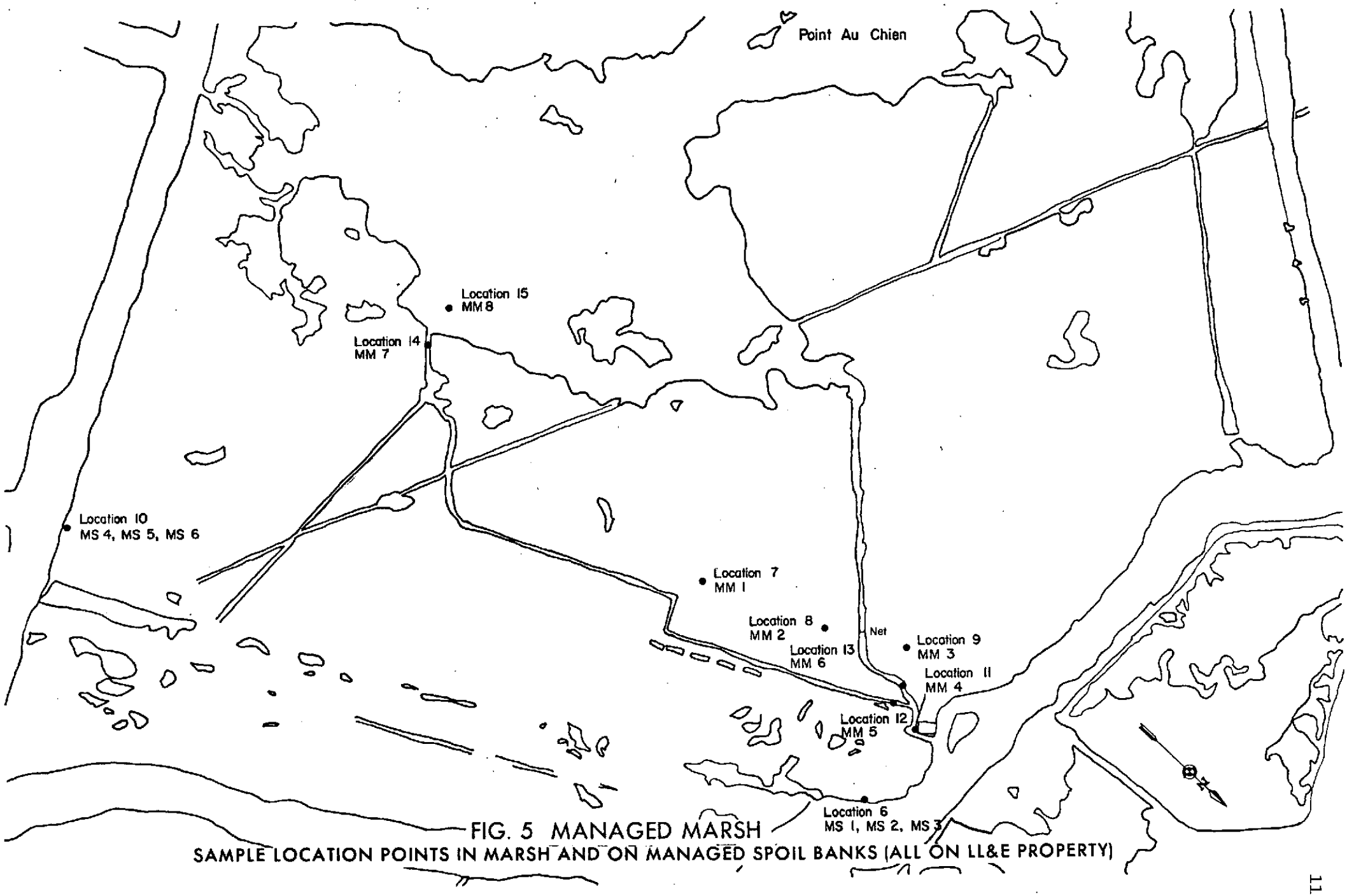

FIG. 5 MANAGED MARSH

SAMPLE LOCATION POINTS IN MARSH AND ON MANAGED SPOIL BANKS (ALL ON LL&E PROPERTY)

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The pH of the Point au Chien marsh samples ranges from 7.4 to 7.8 which is between the saline marsh (8.0-8.2) and the fresh water marsh (6.6-6.8). Spoil banks are more variable in the Point au Chien area ranging from 8.0 at the base to 6.8 at the top of the bank. Bottom samples in channels had the highest pH (8.0). Moisture content ranged from 40-60% in the spoil banks to 80% in the marshes and channels, which is consistent with values found in the fresh water marsh. The salt water marsh has slightly lower values.

The Point au Chien samples are texturally similar to the Fourchon and Lake Boeuf samples. They are fine grained, containing much more silt and clay than sand. Marsh samples contain 21-33% clay, 58-70% silt and 0-14% sand. The managed marshes are very slightly finer (more clay, less sand) than the unmanaged area, which may be the result of man-made spoil banks blocking current flow in the managed area. The spoil banks, found only in the managed area, are much more variable. The tops of soil banks, and the bayou side in one case, can get sandy, with one top consisting of greater than 90% sand. The sides of spoil banks contain more clay (39-91%) than elsewhere which differs from the Fourchon area where the finest sediments were in the center of the marsh.

Chemically, the composition of the Point au Chien sediments are different from both Fourchon and Lake Boeuf samples. As expected, the Cl content was lower than at Fourchon and higher than at Lake Boeuf. In general, all of the chemical species tested for(Table I) are less concentrated than at Fourchon. The spoil banks contain less Cl and phosphates than the marsh or bottom samples. The relative distribution of elements is the same at Point au Chien as at Fourchon (i.e., between spoil banks, marsh, channel, etc). The Lake Boeuf samples were higher in Al, Ca, Fe^{3+} and nitrates while Point au Chien was higher in sulphates and K and Cl.

The unmanaged marsh contains more phosphates, potassium and aluminum than the managed area. Phosphates and potassium are important as plant and animal nutrients. All comparisons can be found in Table I.

It was noticed that patches of genus Junus are found in the marsh at Point au Chien, where the dominate grass genus is Spartina. The sediment (or soil) in the Juncus patches contained more Ca (350 ppm) than elsewhere (150 ppm) although this is based on too few samples to be conclusive, it merits further consideration.

RESULTS

Nekton: The species composition and abundance of fishes and invertebrates was very similar in the managed and unmanaged areas. A total of 25 fishes was taken in the trawl hauls. The unmanaged areas showed a slightly higher diversity being represented by 24 species as compared to 22 in the managed area. Four species of invertebrates were taken by trawl in each area.

The average number of organisms per haul was slightly higher at the managed (16 vs. 53) location. This difference is attributable to the occasional contribution of schooling fishes such as striped mullet (Mugil cephalus) and to sampling error. It is noteworthy that the blue crab (Collinectes sapidus) was more abundant and was considerably larger at the managed location.

The numbers of penaeid shrimp were surprisingly low at each site. Results are tablurized in Table II.

Benthic invertebrates: Amphipods dominated the bottom fauna in each area. Eight different invertebrates were taken in the unmanaged area while 6 were encountered at the managed location. The average number in the managed area was 108 M^2 as compared to 93 in the unmanaged. These

TABLE II

NEKTON TAKEN IN 16' TRAWL IN THE MANAGED AND UNMANAGED AREAS DURING JUNE, JULY AND AUGUST, 1973

			Average Per 10 Minute Trawl	
			Managed	Unmanaged
	FISH			
1.	Alligator Gar	Lepisosteus spatula	0.3	0
2.	Atlantic croaker	Micropogon undulatus	9	7
3.	Atlantic spadefish	Chaetodipterus faber	0	0.3
4.	Bay anchory	Anchoa mitchilli	0	1
5.	Black drum	Pogonias cromis	0	0.3
6.	Gafftopsail catfish	Bagre marinus	0	0.3
7.	Gulf killifish	Fundulus grandis	7	3
8.	Gulf menhaden	Brevoortia patronus	6	9
9.	Ladyfish	Elops saurus	1	2
10.	Least puffer	Sphoeroides parvus	0	0.6
11.	Marsh killifish	Fundulus confluentus	0.3	0.3
12.	Mosquitofish	Gambasia affinis	0.6	0
13.	Pinfish	Lagodon rhomboides	2	2
14.	Sailfin molly	Poecilia latipinna	0.3	1
15.	Sand seatrout	Cynoscion arenarius	3	1
16.	Sea catfish	Arius felis	0.6	6
17.	Sheepshead	Archosargus probatocephalus	0.6	0
18.	Sheepshead minnow	Cyprinodon variegatus	0.6	1
19.	Silver perch	Bairdiella chrysura	0	0.6
20.	Southern flounder	Paralichthys lethostigma	0	0.3
21.	Spot	Leiostomus xanthurus	2	1
22.	Spotted seatrout	Cynoscion nebulosus	1	0
23.	Striped mullet	Mugil cephalus	10	6
24.	Red drum	Scianops ocellata	0.3	0.3
25.	Tidewater silversides	Menidia beryllina	1	0.3
	INVERTEBRATES			
1.	Blue crab	Callinectes sapidus	6	3
2.	Brown shrimp	Penaeus aztecus	4	3
3.	White shrimp	Penaeus setiferus	2	2
4.	Pink shrimp	Penaeus duorarum	0.3	0

differences are not significant in view of the small number of samples they represent.

Results are tabularized in Table III.

Zooplankton: A total of 17 zooplankton types were observed in each area. Copepods comprised about 70% of the samples. The density of organisms per cubic meter was very similar in each area.

Results are tabularized in Table IV.

Tidal Exchange: The results of observations and measurements taken on two separate occasions, one at high tide and the other at low tide, are illustrated in Figures 7 and 8 for Site I; and for Site II, in Figures 9 and 10. Figure 11 illustrates tidal flow in Site II as observed at low tide in November of 1973.

The only avenue of water exchange between Bayou Jean Lacroix and Site I is across the weir. Construction of the weir permits retainment of water in the marsh behind it, even at the lowest of tides when water movement is zero. However, at extremely low tides in Site II the entire marsh can and does drain dry.

Salinity readings taken during the summer showed that salinities of the water in Site I ranged from 3 to 5 ppt lower than that of the Bayou; while the salinities in Site II were generally the same as those recorded from the Bayou.

The control weir shown in Figure 4 was placed at this location primarily to maintain a proper tidal level in the marsh immediately north-northwest of the weir. As determined by the ground teams the marsh does become dry at low tides. The reason can be determined from the color IR photographs which show the entire marsh area interconnected by canals and train accesses. Subsequent to a study of this imagery measurements of

TABLE III

BENTHIC INVERTEBRATES SAMPLED IN THE MANAGED AND UNMANAGED AREAS DURING JUNE, JULY, AND AUGUST, 1973

	JUNE		JULY		AUGUST		AVERAGE-FACTORED			
	Managed	Unmanaged	Managed	Unmanaged	Managed	Unmanaged	Managed		Unmanaged	
Phylum Aschelminthes										
Menatodes	1	0	0	0	0	0	13	0.3	0	0
Phylum Annelida										
Oligochaetes	6	6	2	0	2	3	132	3	3	132
Polychaetes	3	9	0	1	7	3	132	3	4	176
Phylum Mollusca										
Pelecypods	0	1	0	0	1	1	13	0.3	0.6	26
Gastropods	0	1	0	0	0	0	0	0	0.3	13
Phylum Arthropoda										
Amphipods	13	9	4	2	1	5	264	6	5	220
Isopods	0	0	0	1	0	0	0	0	0.3	13
Grass Shrimp	0	1	0	0	0	1	0	0	0.6	26
Insect Larvae	1	3	2	2	4	5	88	2	3	132
AVERAGE							108		93	

TABLE IV

ZOOPLANKTON PER CUBIC METER IN THE MANAGED AND UNMANAGED AREAS DURING JUNE, JULY AND AUGUST, 1973

	JUNE		JULY		AUGUST		AVERAGE	
	Managed	Unmanaged	Managed	Unmanaged	Managed	Unmanaged	Managed	Unmanaged
Protozoa:								
Sarcodina	1365	0	5005	8190	5460	455	3943	2882
Ctenophora	0	0	455	1365	1820	910	1517	758
Coelenterata:								
Hydrozoan medusae	0	455	3185	7280	1365	3185	1517	3640
Annelida:								
Polychaete larvae	0	0	1365	1365	1365	0	910	455
Arthropoda								
Crustacea:								
Copepoda	142870	129,220	39585	55055	45045	48230	75833	77502
Cladocera	4550	2730	3185	0	0	0	2578	910
Ostacoda	910	2275	455	0	0	455	1213	910
Caridea	2	0	1	2	5	3	1	1
Mysidacea	11	5	0	1	4	11	2	3
Penaeid PL	10	10	4	12	6	8	3	3
Nauplei	3185	5915	10920	7735	10465	5915	8190	6522
Zoea	1820	5005	5915	910	0	2730	2578	2882
Chaetoynatha: Sagitta	0	0	0	0	910	1820	910	607
Chordata:								
Oikopleura	0	0	10010	6645	1365	0	3792	2215
Dolioida	0	455	5460	0	0	455	1820	303
Eggs	455	455	455	1365	910	455	607	758
Fish larvae	0	1365	1365	455	455	455	607	758
AVERAGE							6236	5947

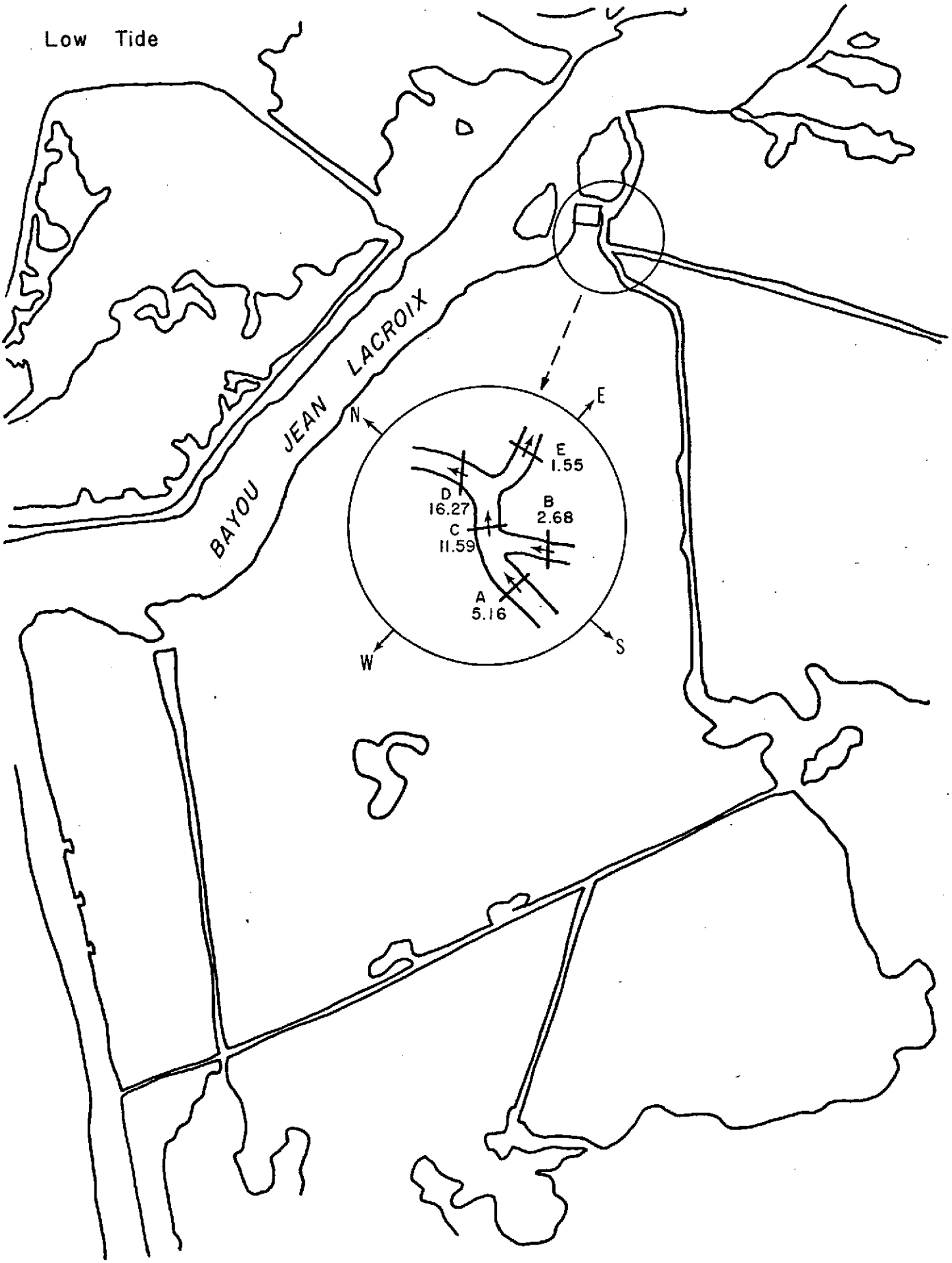

FIG. 7 TIDAL FLOW AS MEASURED ON 7/18/73

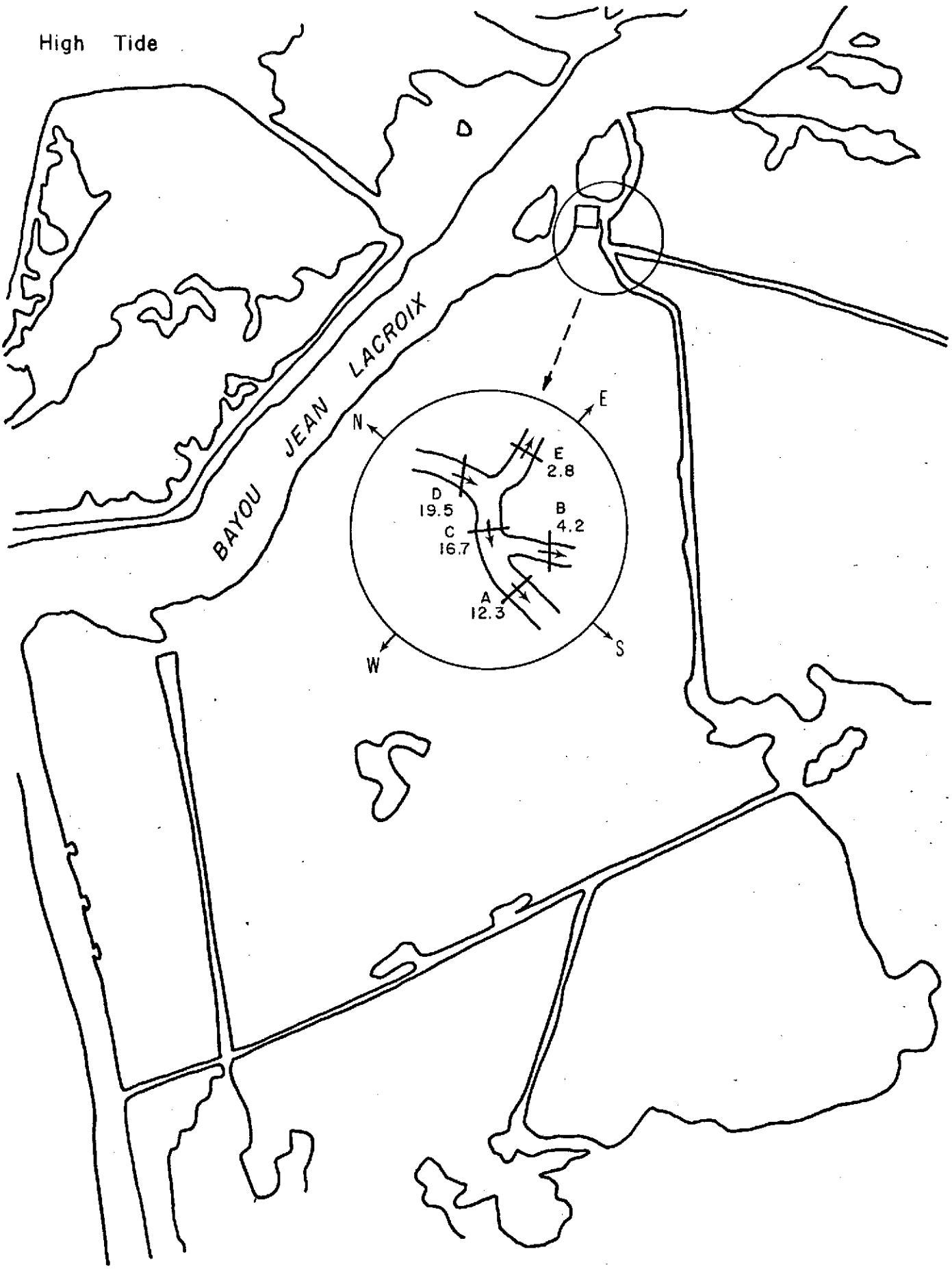

FIG. 8 TIDAL FLOW AS MEASURED ON 6/21/73

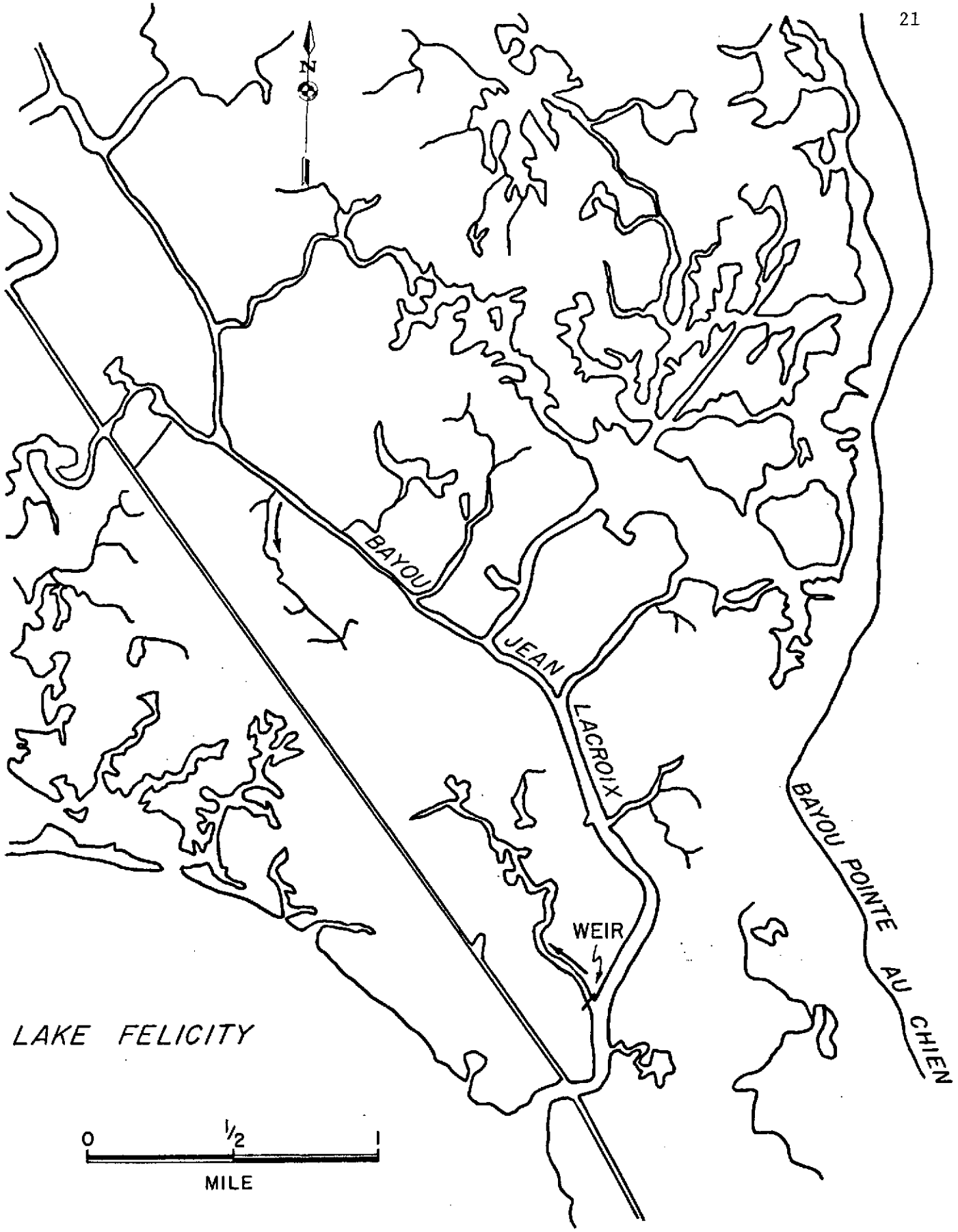

FIG. 9 DIRECTION OF WATER MOVEMENT AT HIGH TIDE AS OBSERVED ON 6/21/73

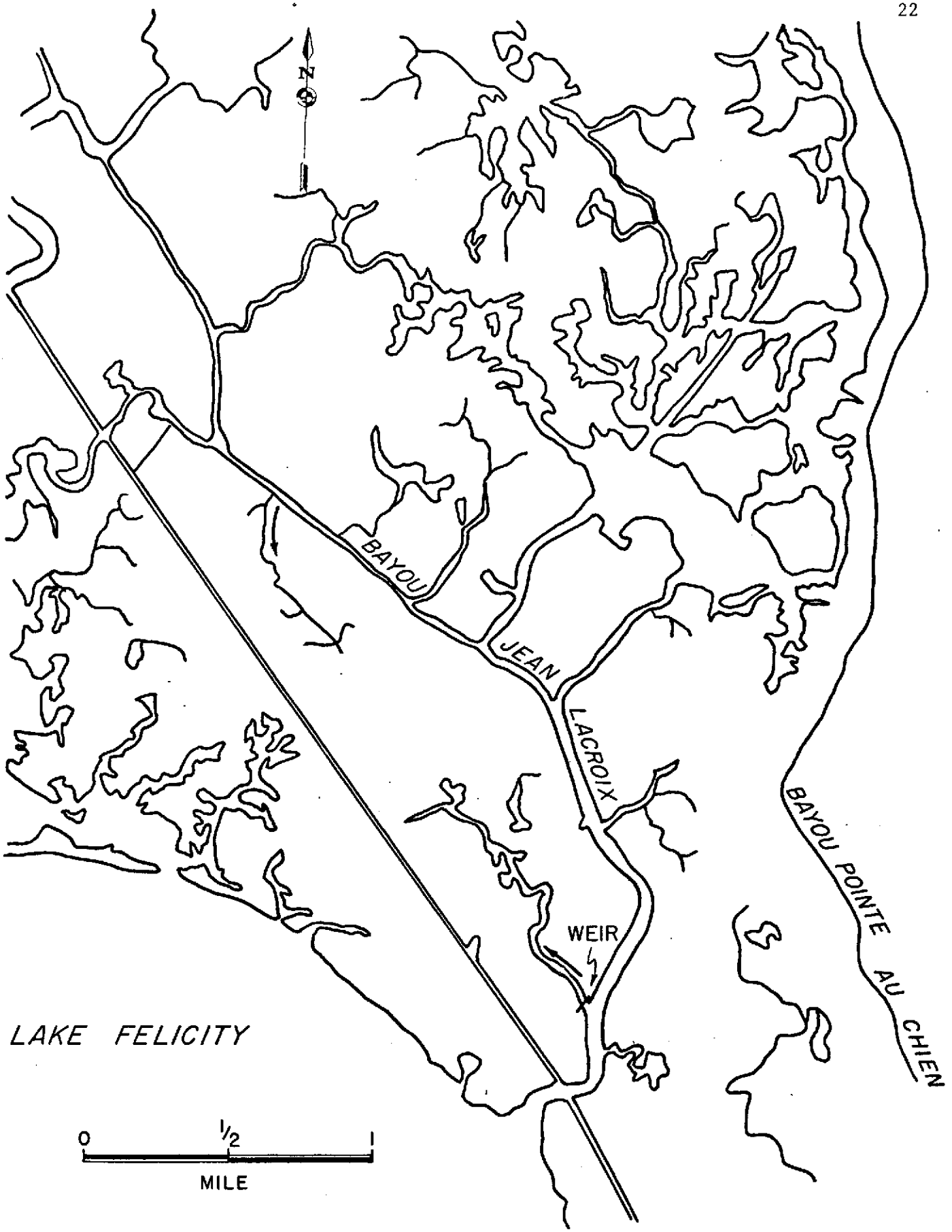

FIG. 10 DIRECTION OF WATER MOVEMENT AT LOW TIDE AS OBSERVED ON 7/18/73 .

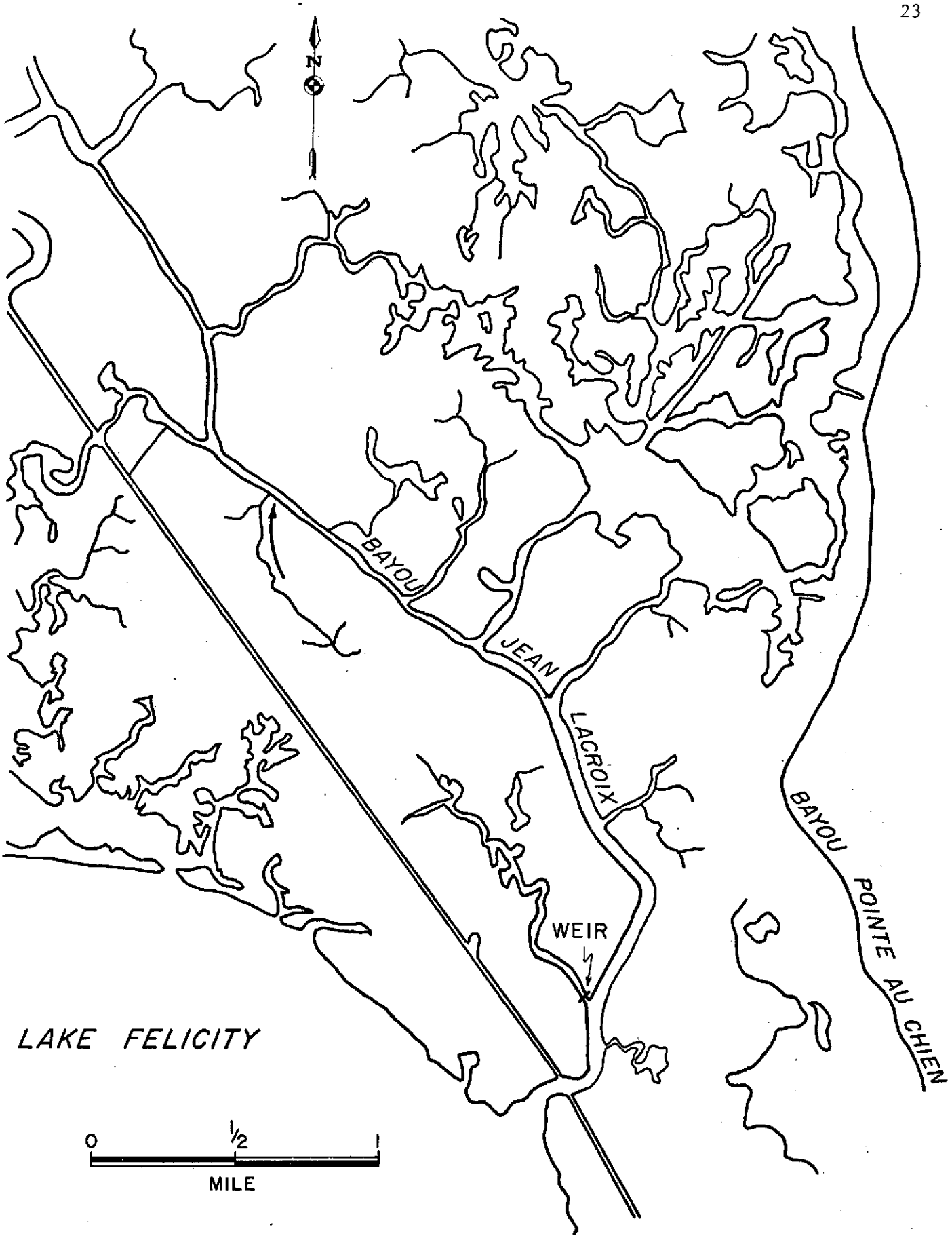

FIG. 11 DIRECTION OF WATER MOVEMENT AT LOW TIDE AS OBSERVED IN NOVEMBER OF 1973

flow rates and directions can be obtained at critical points. The major drainage avenues are easily located.

There are problems in the use of color infrared imagery in sedimentological studies in the marsh areas of South Louisiana. The ground is covered by lush vegetation which obscures the soil and sediments and which may or may not reflect changes in the underlying sediment. Spoil banks, canals, marshes and beaches have been located from the photographs, but they, and the soil differences, especially in texture, are obvious from the ground. Some vegetational changes, like the change from grass to mangrove (1972 report) in the Fourchon area are not related to sediment or soil changes while others, such as the Juncus in the Pointe au Chien area, may reflect such changes. The sediments or soils were relatively homogenious over the marsh areas which included the vast majority of the area covered. Most sedimentological changes were as obvious from the ground as from the photos. The photos do show spoil banks, channels and marshes well and can be used to map large areas of South Louisiana and to locate ancient levees and channels which are not so obvious from the ground (see AOP-2, 1973).

The infrared imagery may be very valuable in the study of sediments suspended in water, the direction of sediment transport and sediment traps by determining discharge patterns.

This study does not negate the use of infrared and other remote sensing devices in other geological investigations such as the location of oil and gas seeps, salt domes, faults, etc.

The brackish water from Pointe au Chien samples showed some properties (pH, Cl content) intermediate between saline and fresh water marshes. Chemical concentrations were less than at Fourchon (saline) for all elements and radicals tested. The distribution of chemical components is similar to Fourchon. The Pointe au Chien marsh samples contained more

silt than either Fourchon or Lake Boeuf (fresh) marsh samples. The marsh grass genus Juncus may indicate more calcium in the soil than in areas where the genus Spartina dominates. Management of brackish marsh areas by placing levees around the area may result in depletion of nutrients, notably phosphates and potassium.

RECOMMENDATIONS

In Site II it is the recommendation of the writers that a weir be placed across the northeast feeder bayou (See Figure 12). Such a weir would stabilize and reduce salinity and water exchange in the complex behind it. This would precipitate the invasion of more desirable plants, which in turn would attract the invasion of fur bearers, such as the muskrat, and migratory waterfowl. The present existence of such organisms in the managed area (Site I) no doubt accounts for the dense muskrat and nutria population which it supports.

However, weir construction involves the outlay of considerable monies and immediate financial return on such an investment should be considered. If an immediate return was of priority then such a weir should not be constructed. However, a long-term investment might prove rewarding in the realization of monies generated through trapping and land leases. As the area would become more productive this in turn would attract those individuals or groups interested in fauna of the site.

It has been observed that the pipe-line canal bordering the west boundary of the Site is not being maintained. We further recommend that this situation be looked into. This condition, and other cases of breached, or damaged, bulkheads, mud plugs, etc., are easily noted from the color IR imagery. Those bulkhead constructed of shell are most readily identified and likewise, if one is damaged, the condition is well defined

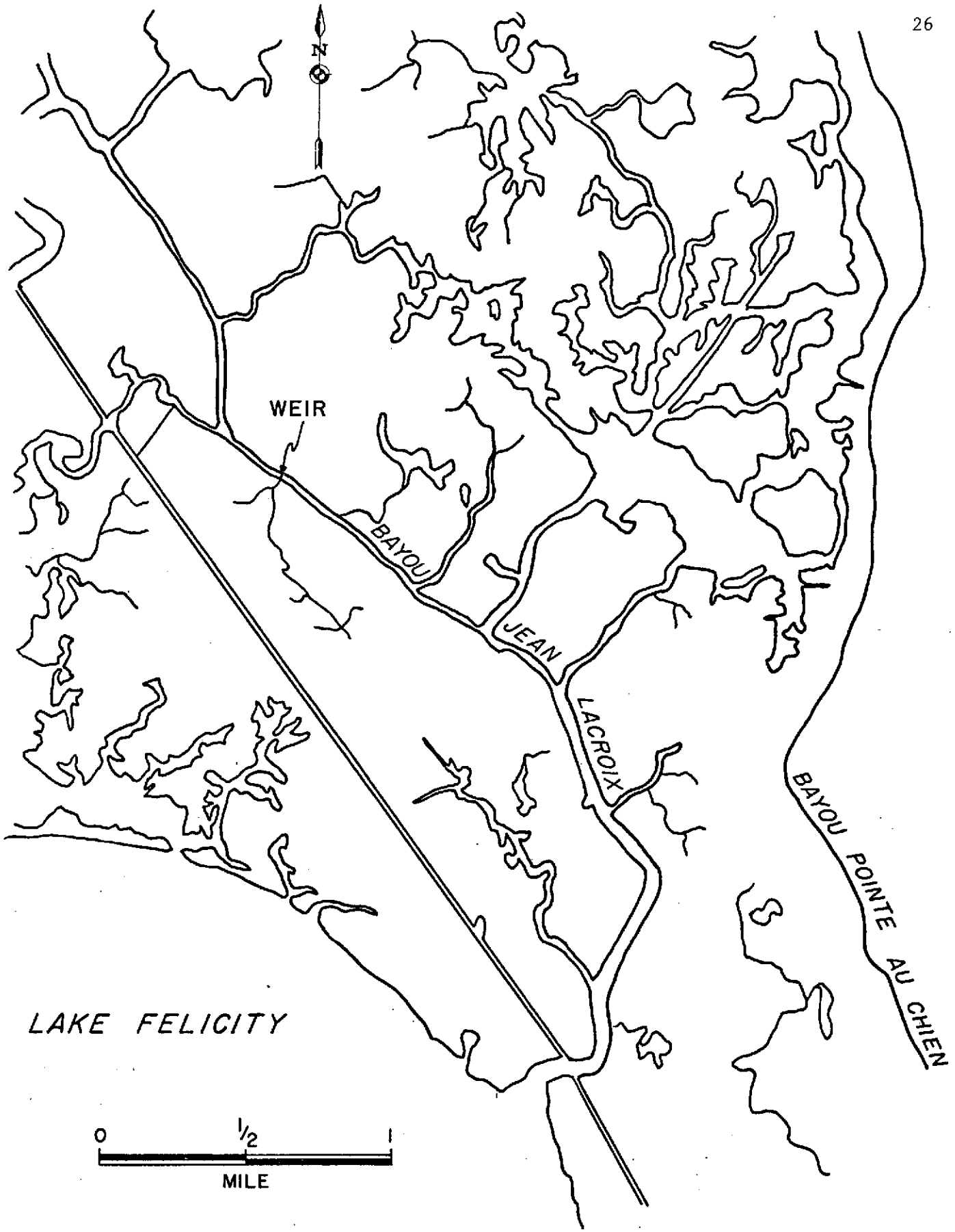

FIG. 12 RECOMMENDED SITE OF WEIR PLACEMENT

on the photographs.

In brackish water marshes, the presence of Juncus may indicate increased concentrations of calcium in the soil. The managed marsh, surrounded by levees, has less nutrients, notably PO_4 and K than the unmanaged and may result in decreased biological productivity. This is a condition which may be detected from color IR imagery.

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