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Louisiana State University
Baton Rouge, Louisiana, 70803

ANNUAL REPORT

ERTS

on

NASA GRANT NGL 19-001-105

INTERPRETATION OF REMOTE SENSING DATA IN THE BAYOU LAFOURCHE DELTA OF SOUTH LOUISIANA

Covering the Period:

February 1975 to May 1976

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Submitted by:

Charles A. Whitehurst, Principal Investigator
Division of Engineering Research
College of Engineering
Louisiana State University

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I. SUMMARY

In 1971, the Division of Engineering Research, Louisiana State University, received a grant from National Aeronautics and Space Administration entitled "Interpretation of Remote Sensing Data in the Bayou Lafourche Delta of South Louisiana" (NGL 19-001-105). Work under this grant was initiated June 1, 1972, with the assistance of personnel from Nicholls State University. Initial efforts were directed toward a comprehensive "ground truth" program and included the participation of several faculty and staff members, graduate students, and nine undergraduate assistants from LSU and NSU.

At the end of the first eight months a program review was held and specific "Action Oriented Projects" (AOP) were defined. These projects were chosen based on the interest shown by state or local agencies, or local private interests. As these projects were completed, they were published as Research Monographs, and reviewed by NASA/OUA personnel as well as local authorities.

In 1976 the research team turned its attention to problems which are not as "action oriented as previous ones but represented a longer range view of economic development possibilities, and environmental management techniques in the delta region. The use of remotely sensed data constituted, in most cases, the basis for our studies. A summary of the results and impact of these projects are reported in the following section.

a. Impoundments in the delta region.

A study of impounded areas has been renewed based on interests by the Coastal Zone Management Commission, the Lafourche Port Commission, and private corporations. We have: (1) supplied imagery to consultants working for the Port Commission and (2) will assist the Center for Wetlands Resources in assessing the impact of impounding an area in a freshwater swamp. The impoundment in question is a valuable forest area and methods of relieving the stress of impoundment will be recommended to the owners and to regional planners.

b. Roseau Cane

The major project of this year was directed toward surveying the Louisiana delta for large areas which were populated by the common reed, *Phragmites communis*, or roseau cane as it is referred to in South Louisiana. The initial effort has been completed and a map of the Mississippi River delta region showing tremendous acreages of cane is in preparation. We estimate that there are 100,000 acres in this area alone. Assuming an equivalent conversion factor of 2bbl of oil per ton of biomass[1] and assuming the recoverable biomass per acre is only 1/3 that of sugar cane (which is the most common commercial crop in this part of Louisiana) then this one area represents a potential resource value of $2\ (10)^6$ equivalent bbl of oil per annum. A $ value cannot be placed on this product simply because the cost of harvesting is not known.

Our project did not rest on surveys by remote sensors alone, but entailed considerable field effort, and the cooperation of several industries. The Interantional Paper Company of Mobile, Alabama and the Valentine Paper Company of Louisiana have both been involved in evaluating the cane as a possible raw material for the paper industry. On the National scene ERDA awarded a contract to the Battelle Memorial Institute to make a sugar-cane survey in South Louisiana and Florida, with the primary purpose being to locate possible agri-fuel farms. Our survey shows that roseau cane is a valuable resource. Efforts to define specific farming areas (or potential sites) will continue and efforts to initiate an industrial participation will be accelerated. The Louisiana Land and Exploration Company has already indicated an interest in farming a large tract in the Des Allemands region. Additional data is needed before any corporation or private enterprise will invest in roseau cane farming.

c. Local Climate in Wetlands and Surplus Precipitation

During the prolonged floods of 1973 and the short-term effect of tropical storms such as Hurricane Carmen a need to know the effect of water surplusses was established. In the region which represents the northern end of the Barataria Estuary the impact of rainfall is extremely important. The fresh water lakes in the area are valuable resources and the nutrient load for the lower part of the estuary passes through these lakes. Too much water has a negative effect. Although this study is being funded by another agency (Department of Interior) the possibility for participating with NASA imagery was evident. Base maps had to be prepared and regional cooperation in data collection (ground truth) had to be encouraged.

A data network for collecting rainfall data was established at the regional schools. In return for the participation of their science classes in collecting the data, we prepared lectures, slide presentations, and training guides on remote sensing. The response has been excellent and some schools are incorporating these materials into their courses.

Based on these experiences the preparation of additional material to be used in educating not only school faculty but also state agency and industrial personnel has been proposed to NASA.

d. Research Support - Department of Interior, Office of Water Resources & Technology

A 5 million dollar catfish farming industry in the Lac Des Allemands area could be seriously affected by industrial activities in the upper reaches of the Barataria estuary. OWRT funded a program to assess the activities of the energy industry, including oil and gas exploration, production, transportation and processing. In order to meet the requirement of this program (OWRT) the Joint Legislative Committee on Environmental Quality (JLCEQ) was asked to provide basic support data, data handling (or computer services) and available assessment methodologies. The OWRT contract alloted $10,000 for this service. In support of this effort by the JLCEQ we would supply them with data collected by remote sensors or data collected which was indirectly related to the use of sensors. We accomplished this by preparing overlays from infrared imagery, including vegetation maps, ecosystem definitions, land use, water ways, and environmental data such as impounded areas etc.

We undertook these tasks (and accomplished them) assuming that we would help them justify the implementation of the Louisiana Environmental Management System (LEMS), management program developed by the Joint Committee.

A parallel program was conducted by the Joint Committee, the Louisiana Scenic Rivers Commission, and scientists from the NASA/NSTL technical support group. Our data was also to be used in support of this work.

The LSU team has never received any assistance from JLCEQ toward meeting the OWRT goals. Our data was either not processed or has not been returned due to the apparent failure of the LEMS program. We have asked and received from OWRT permission to use the $10,000 to complete the original objectives.

A report of the data prepared for the JLCEQ and for use by our research teams in contained in the next section of this report.

II. PROGRAM REVIEW: 1975-1976

A. Study of Impounded Areas - Backwater Swamp

In 1974-1975 a study of marsh areas which were impounded or subject to impoundment was undertaken. Interest in this effort was generated through the Lafourche Port Commission, who had plans to commercially develop an impounded area north of Port Fourchon. The results of this study were discussed in our last report including the fact that Hurricane Carmen proved to be disastrous. Meaningful conclusions were evasive and the study temporarily discontinued.

In the past year the questions of environmental management and impoundments in a freshwater swamp were raised in the Lac Des Allemands area. The oil and gas activity in this region is intense and environmental changes are causes for concern. In order to better understand these changes and to generally support a research effort funded by the Office of Water Resources Technology related to the impact of energy activities, our interest in impoundments was revived.

The study area is located in the backswamp south of Lower Vacherie, Louisiana; at approximately latitude 29°55'N. by longitude 90°41'W. See Figure 1. The area which shows greatest effects of environmental change is a three square kilometer polygon. The area is bounded by State Highway 20 on the west, Bayou Chevreuil on the south, an unnamed series of oil and gas platform access canals to the north and northeast and an indistinct eastern boundary on the east extending possibly as far as Lac Des Allemands. See Figure 2.

The initial objectives of this study were: 1) to justify the use of infrared aerial photography as a tool in the design of environmental management

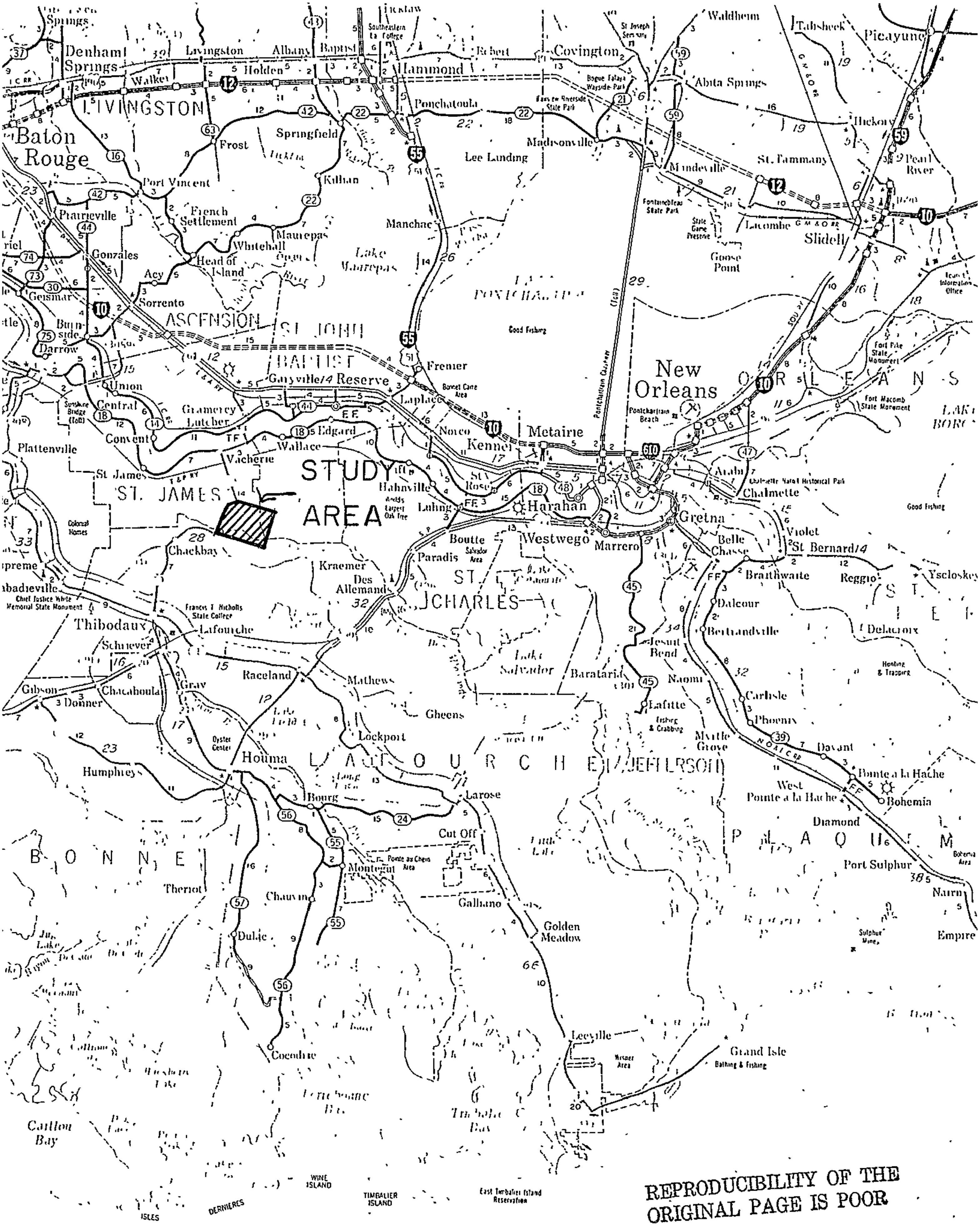

Denham Springs
Livingston
Albany
Baptist
Robert
Covington
Picayune
Walker
Holden
Hammond
Abita Springs
LIVINGSTON
Ponchatoula
Baton Rouge
Springfield
Frost
Madisonville
Lee Landing
Mandeville
St. Tammany
Port Vincent
Killian
Pearl River
French Settlement
Prairieville
Manchac
Lacombe
Slidell
Whitehall
Maurepas
Gonzales
Head of Island
Lake Maurepas
Goose Point
Acy
Geismar
Sorrento
Good Fishing
ASCENSION
ST JOHN
BAPTIST
Darrow
Burnside
Union
Gaysville
Reserve
Fremer
New Orleans
ORLEANS
Central
Gramercy
Lutcher
Laplace
Convent
Edgard
Wallace
Norco
Metairie
Kenner
Plattenville
St James
Vacherie
STUDY AREA
Hahnville
St Rose
Chalmette
ST. JAMES
Luling
Harahan
Gretna
Violet
Boutte
Westwego
Marrero
Belle Chasse
St Bernard
Chackbay
Paradis
Kraemer
Des Allemands
ST. CHARLES
Braithwaite
Reggio
Ycloskey
Thibodaux
Lafourche
Dalcour
Schriever
Bertrandville
Delacroix
Raceland
Mathews
Lake Salvador
Barataria
Jesuit Bend
Naomi
Gibson
Donner
Chacahoula
Gray
Lafitte
Gheens
Carlisle
Phoenix
Lockport
Myrtle Grove
Houma
LAFOURCHE
JEFFERSON
Davant
Humphreys
Larose
Pointe a la Hache
West Pointe a la Hache
Bohemia
Bourg
Diamond
Cut Off
PLAQUEMINES
Port Sulphur
TERREBONNE
Montegut
Theriot
Chauvin
Galliano
Nairn
Golden Meadow
Empire
Dulac
Leeville
Cocodrie
Grand Isle
Caillou Bay
Timbalier Bay
WINE ISLAND
TIMBALIER ISLAND
ISLES DERNIERES

Figure 1

SITE LOCATIONS — O

Figure 2

systems, i.e., the design and placement of engineering structures to be used in the relief of impoundment stress; 2) to explore the quantity and quality of information derived solely from the imagery; and 3) to recommend and define what ground truth data is required for an assessment of the causes and environmental impact of impoundment in the backswamp environment. This third objective will be accomplished in the next reporting period.

The aerial photographs used in this study were both high and low level color infrared and high level black and white infrared. The high level black and white and color IR photos were flown October 1974. This imagery, as well as the low level color IR photos which were flown October 1975, was supplied to the research team by NASA/ERL.

In addition to the infrared photography, conventional low level panchromatic aerial photos from the USDA flown in April 1940 and January 1953, supplied historic data for the area. These photos were used to compare the effects of impoundment on the backswamp environment. They also showed what changes had occured in the landuse practices in the area; some of which could be responsible for the normal drainage flow.

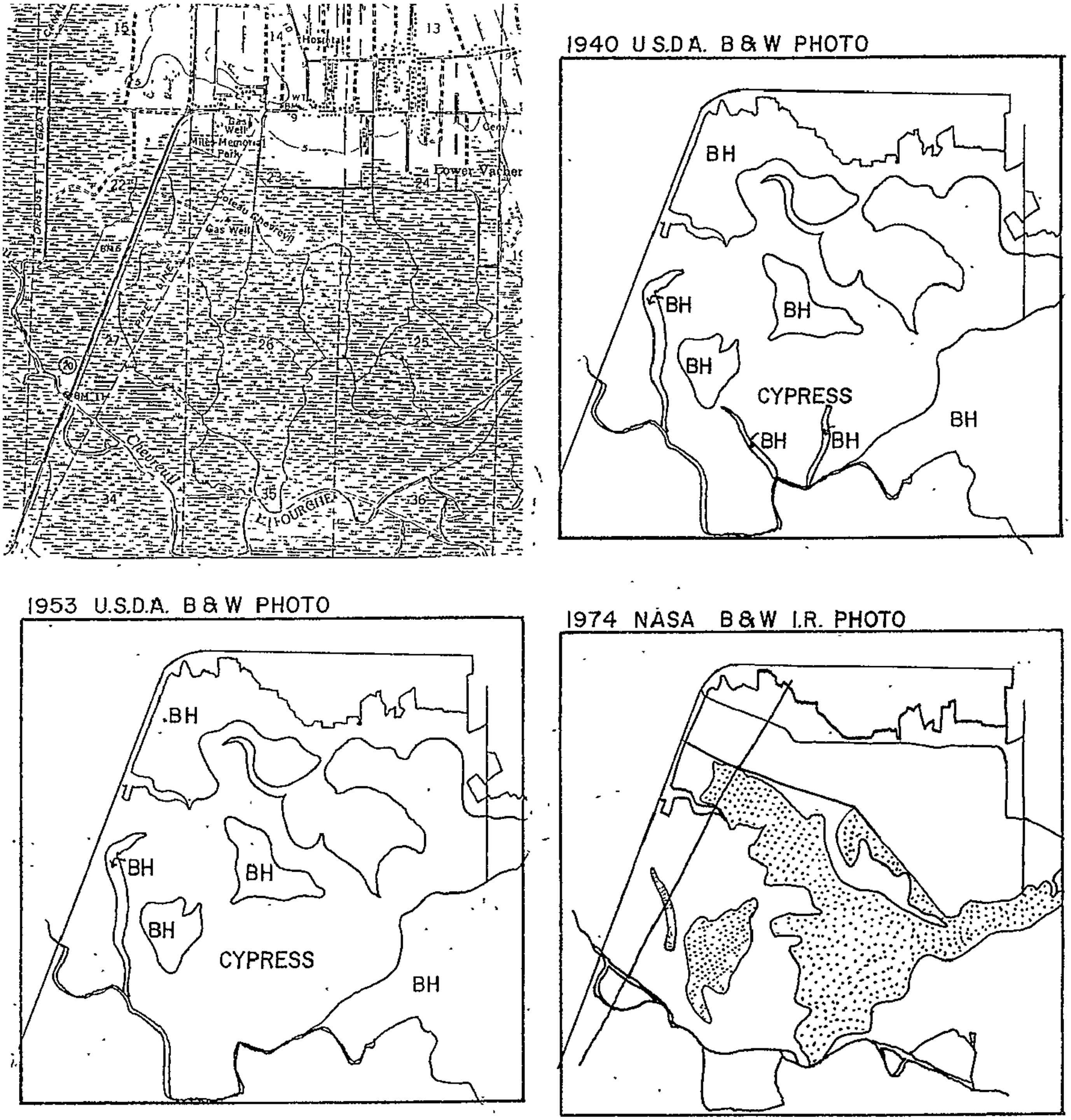
A detailed study of the imagery cited above showed that areas of the backswamp not subject to the normal surface and subsurface drainage are impounded. Changes in the surface water levels, as well as subsurface water table levels, cause an alteration in the visual characteristics of vegetation as it adapts to the changing environment and of the underlying soil. The area is distinctly lighter in tone than the surrounding backswamp vegetation because: 1) less light is being reflected by the vegetation because it is thinner in this area, and 2) the less moist soil reflects more than the wet soils characteristic of the backswamp.

A major incidence of indigenous vegetation growth rate change and population density has occured in recent years in the study area. If the outline of the obviously affected area is to be considered as the limit of disrupted influence, then the series of oil and gas platform access canals and the resulting spoil banks across the north and northeast boundary is the cause of the impoundment. The spoil material has been placed exclusively on the south bank of the canals. Past experience has shown that spoil banks are capable of blocking overland drainage sufficiently for environmental alteration.

Maps of the major vegetation groups for the area were drawn from aerial photographs spanning 35 years. Since no ground truth data was available, interpretation was based solely on the imagery. See Figure 3.

Until the access canals were dug, impact from the gradual development and increased agricultural use and logging has been slight. In effect, the alteration of the environment has been slow enough for the vegetation to adapt successfully without outward signs of disruption. The color infrared photos show what appears to be dead or dying vegetation over the impounded area. The color ranges from a light tan to brown and contrasts sharply with the red and green for normal healthy vegetation elsewhere in the backswamp. The straight line of the access canals separating the the impounded area from the area of normal drainage between the natural levee and the canals is definitely not a natural occurence. Such sharp boundary definitions are rare in nature and are usually characteristic of manmade structures.

The hypothesis presented here is the diversion of overland flow over the study area has prevented the nutrients washed from the sugarcane fields from enriching the backswamp soils. Also, the flushing action of the normal drainage



LEGEND

BH – BOTTOMLAND HARDWOODS

IMPOUNDMENT

Figure 3

brought in fresh water and carried deoxygenated stale water out of the system.

The IR photos show verdant lush vegetation along the margins of the sugarcane fields. The absence of the nutrient high runoff has caused a thinning of the herbaceous and shrub undergrowth in the impounded area. The region can no longer support this heavy growth. The situation is analogous to excess nutrification in a body of water. Effects on trees and other woody plants are evident as the vegetation is much less dense than other areas in the backswamp.

The infrared aerial photographs provide an overall view unavailable to observers at ground level. Since the primary effects of impoundment are on vegetation, ground truth data on the current status of the vegetation is necessary to determine the magnitude of the environmental alteration. We propose an extensive data collection effort in the next year. For instance ground truth sites will be located at the oil and gas platform two kilometers east of State Highway 20 where easy access to the major vegetation groups in the area will be provided. Transects here will provide optimum samples for typing and species counts. Tree ring analysis from selected specimen should give a record of growth and mark any changes in the environment. Other proposed sites for sample collection and observation are shown in Figure 2.

Soil and water quality samples can be collected at the same sites as the vegetation samples. In addition, sufficient data for construction of a detailed hydrologic model for this area could be collected. This would entail the placement of rain gauges and gaging stations along certain canals and streams in the area. A complete study of rainfall and surplus moisture in this region was undertaken in this period. Junior and elementary school science classes were asked to participate in this element of our program. Our participation with the schools is discussed in a later section of this report.

Determination of the amount of runoff and of flow routes of the water flowing overland and in channels could provide a basis for future programs to alleviate the impounded condition. Recommendation for placement of water gaging stations is contingent on the preliminary data obtained from ground crews on rainfall and other pertinent data.

B. Roseau Cane - A Possible Source of Energy in the Louisiana Delta

As cosmopolitan as the common reed (*Phragmites communis* Trin.) is, it has been afforded only minimum attention in the United States. With the advent of recent concern for marshlands (Gosselink, Odum and Pope, 1973) the common reed may be ranked among the vegetation that gives marshes considerable value.

A popular (and perhaps the only) use of *Phragmites communis* (locally known as "roseau cane") in Louisiana is as a "dressing" for duck blinds. Elsewhere the use of *Phragmites* is less limited. In Britain, it is used in the large-scale thatching industry (Haslam, 1968). *Phragmites* is used in the Netherlands to stabilize wetlands in the reclamation of new land (Haslam, 1968). The shafts of *Phragmites* have been used as quill pens (Moldenke, 1954; Dimbleby, 1967) and sugar has been extracted from the roots (Hedrick, 1919). It has even been used as a source of vegetable dye which produces a green color from the flower heads (Dimbleby, p. 54, 1967). The intensity of recent interest revolves around the commercial use of *Phragmites communis* in the cellulose industry. Clark (1954) rejoices that the reeds of the Danube delta produce unique fibres of a desirable softness for tissues, towelings, and lens papers. The reeds are used to produce printing and writing papers in Rumania, USSR, Denmark and Egypt (Haslam, 1968). The feasibility and relevancy of producing methane (Thomas B. Reed, MIT, correspondence) from Phragmites fibres is also generating domestic interest with the urgency of finding new sources of replaceable raw materials.

Phragmites communis is a worldwide phenomenon and a species of ecological interest that inhabits the fresh to brackish marshes. It is abundant in river floodplains, in marshes, in seeps, in ponds, on shores of water bodies, on spoil banks, and along canal banks. The Greek name came from reference to its growth pattern -- like a fence (phragma) along streams (Hitchcock, 1935).

The northern limit of Phragmites communis is Finmark, Norway, 70°299' (Dahl, 1934) and while being profuse in temperate regions it is an uncommon speices in the tropics (Haslam, 1968). Dr. Elso S. Barghoorn of Harvard University compiled the distribution of Phragmites in the United States from herbarium sheets of the Gray Herbarium. (Figure 4 illustrates these locations.) In Louisiana, specifically, Phragmites is a dominant species in the birdsfoot delta and is located sporadically along the coastal marshes. (See Figure 5 for a general distribution map of Phragmites in Louisiana.)

One aspect of this project is to map the distribution of Phragmites communis in the coastal marshes of Louisiana. This study also encompasses correlating the morphological environment of Phragmites to the existing edaphic conditions and thereby supplementing our knowledge of environmental requirements necessary for optimum growth as preliminary information for possible agricultural potential in Louisiana. The ultimate goal, of course, is to determine the economic feasibility of establishing agri-energy farms in the

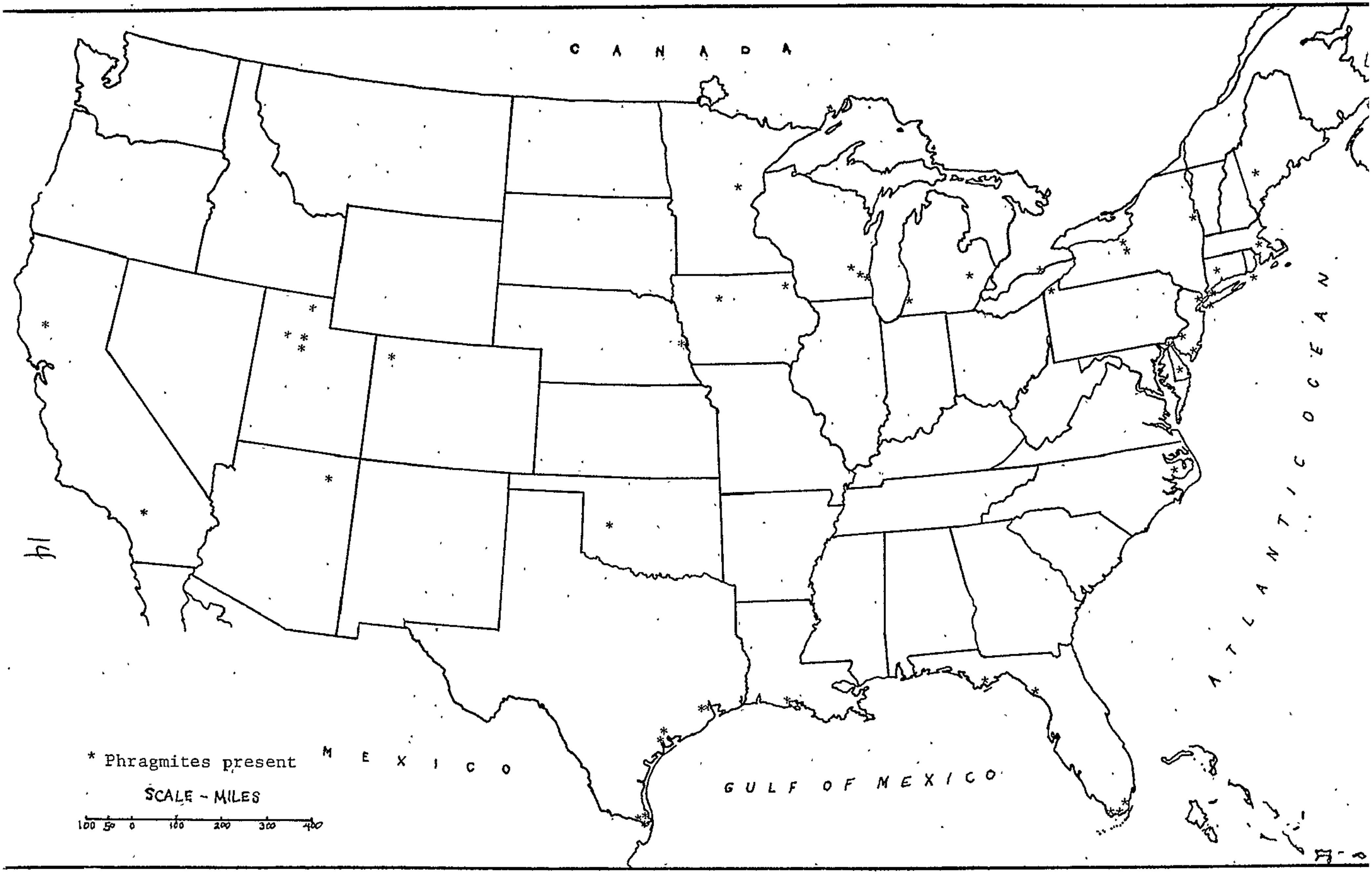


FIGURE 4. - DISTRIBUTION OF PHRAGMITES COMMUNIS IN THE U.S. (data plotted from herbarium sheets, Gray Herbarium by by E.S. Barghoorn, Harvard University, 1973, unpublished)

FIGURE 5 - DISTRIBUTION OF PHRAGMITES IN LOUISIANA. (Plotted from herbarium sheets, LSU herbarium, and from personal observation.

delta, assuming environmental constraints are satisfied. The following paragraphs represent a summary of work accomplished to date. Proposed work has been presented in a continuation proposal to NASA.

Field Research

Fifteen selected Phragmites sites have been studied during the spring and summmer of 1975. Of the fifteen sites, four are located on natural levees in the delta, four are on floodplains, two are on spoil banks, one is on a back ridge, and four are on roadside marshes. These include: T1 (North Pass) 1.2 miles north of North Pass on Rt. 55 between Lake Maurepas and Lake Maurepas and Lake Pontchartrain (Manchac, La. 7.5' quad); T2 (West Middle River) 1.5 miles west of W. Middle River Bridge on Rt. 90 (Rigolets, La. 15' quad); T3 (Pearl River) on west bank of the Pearl River three miles north of Rt. 90 (Nicholson, La. 15' quad); T4 (Salt Bayou) on the Salt Bayou near junction of West Pearl River (Rigolets, La. 15' quad); T5 (Chef Menteur) on the roadside on Rt. 90 near Venetian Isles (Chef Menteur, La. 7.5' quad); T6 (Hingle) in the Mississippi River delta at the junction of Hingle Pass and Joe Brown Pass; T7 (Joe Brown Point) in the delta at the junction of Joe Brown Pass and Raphael Pass; T8 (Brant Island) in the delta at the eastern point of Octave Pass and Brant Bayou Pass; T9 (Mack's Pond) in the delta on Raphael Pass (T6–T9 all located on the East Delta, La. 15' quad); T 10 (Petit Lac Des Allemands) approximately one mile southeast of Godchaux Canal (Des Allemands, La. 7.5' quad); T 11 (Bayou Des Allemands) near Victor Canal (Des Allemands, La. 7.5' quad); T 12 (Sabine Spoil Bank) on the Back Ridge Canal one mile from Rt. 27 (Cameron, La. 15' quad); T 13 (Sabine Back Ridge) on the Back Ridge one half mile southwest from the Back Ridge Canal (Cameron, La. 15' quad); T14 (Lacassine Wildlife Refuge on the American Pipeline Canal spoil bank (Grand Lake West, La. 15' quad); and T15 (Rockefeller) in the Rockefeller Wildlife Refuge, Lake No. 14, near Floating Turf Bayou (Constance Bayou, La. 15' quad).

A morphological profile (100-300' long) of each site has been established by use of surveying equipment. Along each transect, vegetation and water depth was recorded (data is prepared from records made at the time the transect was established; it is to be noted that water depth is subject to fluctuations due to tidal influx---such variation was beyond the present scope of this project). Soil and water samples were also extracted.

Relative differences in elevation can readily be seen as well as water depth, and variation in vegetation. Profile examples of two sites (Salt Bayou T4, and Joe Brown T7 Mississippi River delta) are illustrated in Figures 6 and 7. The Salt Bayou profile illustrates a pure Phragmites (100% Phragmites communis) stand with only alligator weed (Alternanthera philoxeroides) at the beginning of the transect. The Salt Bayou transect measured a distance of 118 feet with no vegetation change; the cane continued for an unestablished distance. Elevation change was minimal with only a dropoff at the shore. In the delta, the landform was less compact and the site contained 25% elephant ear (Colocasia esculenta). The Joe Brown transect was measured to a distance of 70' at which point the land became unstable and impassable. Phragmites, however, did continue to Joe Brown Pass. The height of the cane at Salt Bayou and Joe Brown were 10-12' and 14-16' respectively.

Analysis

Water samples from each site have been extracted for determination of relative water salinity. The range is as follows (Table 1 and following):

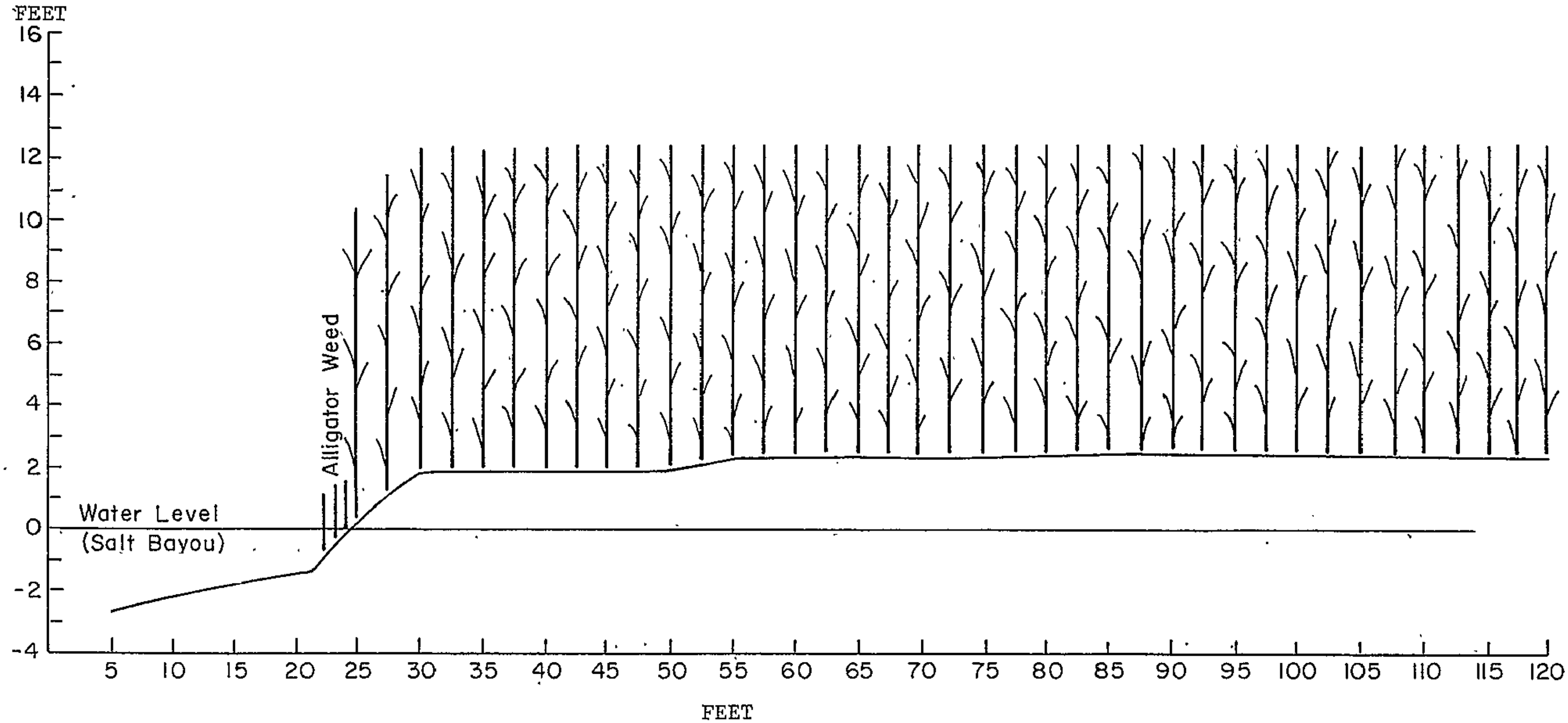


FIGURE 6. Salt Bayou Transect No. 4.

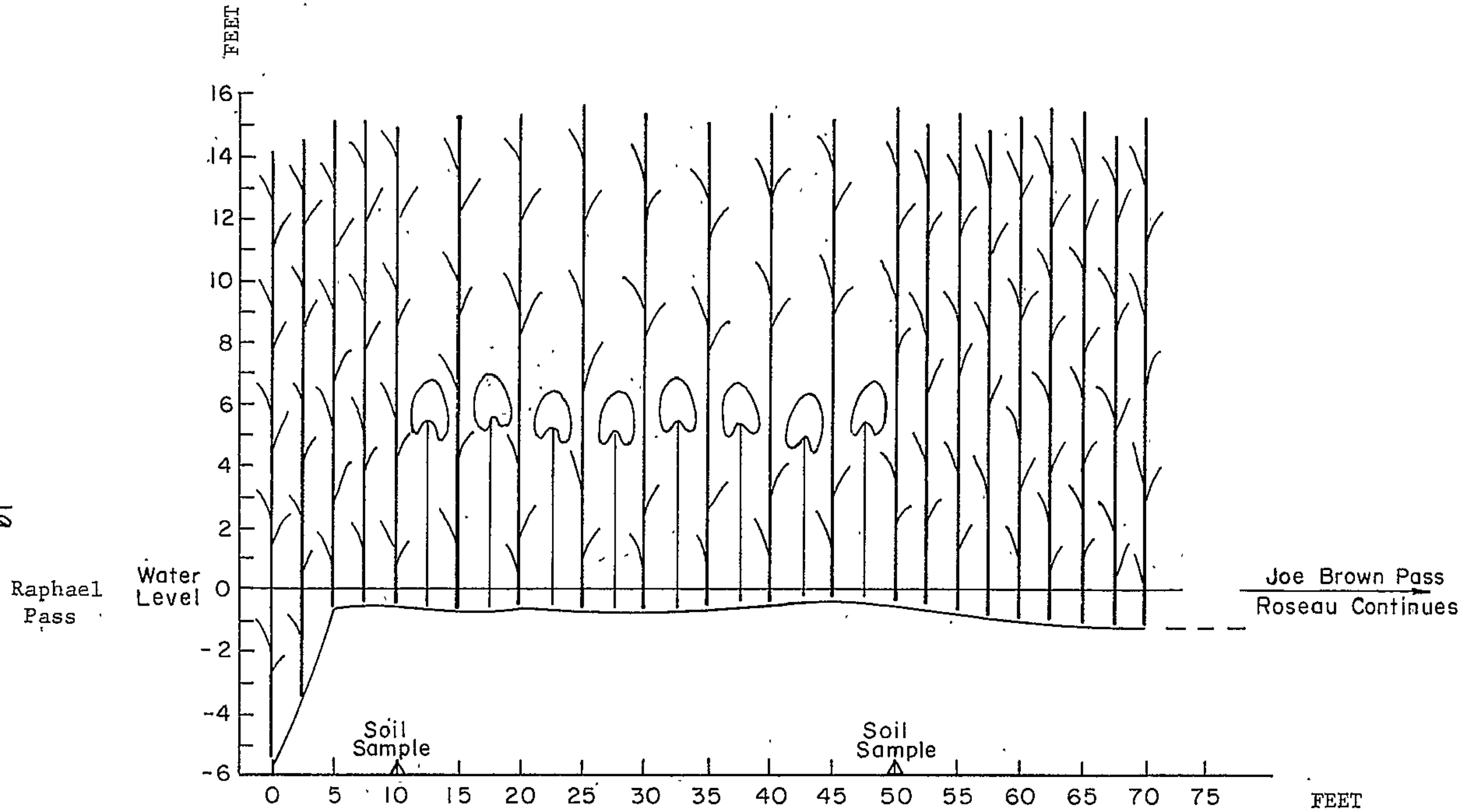


FIGURE 7. Joe Brown Transect No. 7.

TABLE 1

WATER SAMPLE	% SALINITY
T3 Pearl River	.1256
T4 Salt Bayou	.1545
T6 Hingle	.1960
T7 Joe Brown	.1401
T8 Brant Island	.1256
T9 Mack's Pond	.1545
T 10 Petit lac des Allemands	.1401
T 11 Bayou des Allemands	.1960
T 13 Sabine Back Ridge	3.98
T 15 Rockefeller	.4812

The height of the <u>Phragmites communis</u> stand has been recorded for each site. Stands in the delta are the tallest--14-16', whereas those of the Pearl River, Bayou des Allemands, and Rockefeller sites are 10-12'. The shortest stands were in the Sabine Back Ridge area, attaining a height of 6' or less.

By using a meter sampling square, density measurements have been determined in the <u>Phragmites</u> vegetation zone along each transect. In this way we are able to make comparisons between a mixed stand and a pure stand.

PURE	INDIVIDUALS
T2 West Middle River	76 roseau
T3 Pearl River	134 roseau
T6 Hingle	48 roseau
T 10 Petit lac des Allemands	72 roseau
T 11 Bayou des Allemands	85 roseau

MIXED	INDIVIDUALS
T4 Salt Bayou	45 roseau 27 arrowhead 5 pennywort
T5 Chef Menteur	14 roseau 8 marsh elder 21 composite
T7 Joe Brown Point	21 roseau 35 elephant ear
T8 Brant Island	95 roseau 40 elephant ear
T9 Mack's Pond	100 roseau 35 elephant ear
T 12 Sabine (Spoil Bank)	29 roseau 16 French mulberry
T 13 Sabine Back Ridge	70% roseau 20% sp. patens 10% water
T 14 Lacassine	22 roseau with vine
T 15 Rockefeller	112 roseau intermixed grasses

Soil samples have been attained from each vegetation zone along each transect. Approximately three samples were taken at each site. Analyses of these samples include grain size analysis, soil reaction (pH), percentage of moisture content, soluble salt content, percentage of organic matter, and cation exchange capacity. From the processed data, we are able to observe these ranges:

soil reaction (pH) -- from 4.5 to 7.2
percentage of organic matter -- 1.1% to 19.6%
percentage of moisture content -- 25% to 85%

Delta soils range in texture from sandy loam, loam, silty loam through silty clay loam. Other soils include sands, silt loams, clay loams, silty clay loams, and clays. Soluble salt content and cation exchange capacity analyses are near completion.

Mapping

Delta Ground Truth (June 16-20, 1975). Four test sites located in the Delta-Breton National Wildlife Refuge were chosen to determine the credibility of the classification system as calculated from the multi-spectral response of Phragmites communis. Attempts at mapping roseau cane from color infrared aerial photography at elevations of 30,000 - 60,000' have been unrevealing since it is difficult to distinguish roseau cane from other vegetation by color or height parameters at such altitudes. This difficulty can be more clearly understood when we realized roseau cane grows in small strips (5.0'x 10'0) and patches and that only in the delta does it assume expansive patterns that can more readily be detected.

Study in the delta was limited to Octave Pass, Brant Bayou Pass, and Raphael Pass because of the vehicle utilized and in order to not intrude upon a heronry. Furthermore, the study of these four sites included the following:

1.) to illustrate the field research of roseau cane;

2.) to determine other vegetation in association with roseau cane;

3.) to suggest what threshold limit on the Gaussian distribution curve for the multispectral response of roseau cane proves most accurate;

4.) to seek the possibility of separating multispectrally between roseau cane and other vegetation during another season.

Classification

To determine how accurately roseau cane has been determined under the LANDSAT classification necessitates more field research. The four sites studied in the delta illustrate only a limited portion on so complex a system as the delta; generalizations from this data, therefore are preliminary.

We can, however, suspect error in the classification since it maps roseau cane in areas not colonized by roseau. Two examples are Breton Island and the Chandeleur Islands where colonization of roseau cane appears in the 95%, the 99% and the 99.9% threshold limits on the LANDSAT classification. Mr. Cecil McMullen, Delta-Breton National Wildlife Refuge Manager states that no roseau cane is present in these areas. (Personal Communication.)

Roseau cane appears to be present along the entirety of Raphael Pass in both the 99% and the 99.9% threshold limits. However, roseau cane is not present on Raphael Pass until one reaches Little Lake Pond, which leads us to believe from personal observation on Octave Pass, Brant Bayou Pass, and Raphael Pass, that the 95% threshold limit represents a somewhat more accurate roseau cane distribution.

Aerial Photography

Low level color-infrared aerial photography supplied by ERL is presently being used to map the presence of Phragmites in a portion of the delta. Textural identification of roseau cane at this altitude is possible and reliable. From this data approximate acreage of existing communities of roseau cane will be determined.

A flight line in the delta at an altitude of 10,000' was flown by ERL during December 1975 obtaining color-infrared imagery. This photography will be scrutinized for the feasibility of mapping Phragmites at this scale. Hopefully, a map will be the outcome of this attempt.

A summary report on this project was submitted to NASA/ERL personnel in July 1975. A copy of this report is attached in Appendix A.

BIBLIOGRAPHY

Barghoorn, Elso S., 1973, Gray Herbarium, Harvard University.

Clark, T.F., 1964, Plant Fibres in the Paper Industry, Economic Botany 19: 394-405

Dahl, O., 1934, Floraen in finmark fylke, Nyt Mag. Naturvid 69: 430.

Dimbleby, G.W., 1967, Plants and Archaeology, John Baker, London, England, 187 p.

Gosselink, James G., Odum, Eugene P., and Pope, R.M., 1973, The Value of the Marsh, Louisiana State University, mimeograph, 28 p.

Haslam, S.M., 1968, The Biology of the Reed (Phragmites communis) in Relation to its Control. 9th British Weed Control Conference 1968 Proceedings Vol. 1: 392-397

Hedrick, U.P. ed., 1972, Sturtevant's Edible Plants of the World, Dover Publications Inc., New York, New York, 686 p.

Hitchcock, A.A., 1950, Manual of the Grasses of the United States. U.S. Department of Agriculture Miscellaneous Publication 200. 1051 p.

McMullen, Cecil, 1975, Delta-Breton National Wildlife Refuge Manager, Venice, Louisiana, personal communication.

Moldenke, Harold N., 1954, Economic Plants of the Bible, Economic Botany 8: 153-163.

C. Water Surplus and Related Problems

The years 1973 and 1975, especially the spring months were record setting times with respect to rainfall, flood levels, and in general, a large surplus of freshwater in the Lafourche delta. The topography in the freshwater reaches of the Barataria estuary, especially around Lake Boeuf and Lac des Allemands, is such that runoff is subtle. Drainage, and percolation through the swamp areas is generally desirable since nutrients from the ridges are usually water borne to the lower areas.

The control of surplus water run-off by designing structures (canals, weirs, etc.) to optimize the nutrient flow in the swamp is of interest to farmers in the area, and especially to those companies who own the major hardwood areas. Available data on rainfall and surpluses are meager and the LSU research team realized the need for more localized data collection. Models will not adequately predict the water surpluses, or water budgets in the region.

In order to obtain rainfall data systematically nine schools were provided with gauges and instructions on how to collect the data. In turn we obligated a portion of our research time to: (1) prepare lectures for the science classes on remote sensing; (2) prepare displays for the classes; and (3) develop classroom exercises for interpreting the imagery. The level of education ranged from the 6th grade of elementary through the 9th grade of junior high school. A sample of the notes prepared for each class is provided with this report in section b. Only one copy of the imagery is provided since the cost of reproduction would be prohibitive.

It is anticipated that other schools will continue to obtain data and that we will provide them with additional lectures, imagery, and other material.

We intend to use the data collected by the schools in conjunction with that obtained from the regional weather stations to determine local water surpluses. We will then project the station data over described areas in the Lac Des Allemands region. (Section a below discusses the water surplus project).

The data used in climatic studies to date were obtained from regional weather stations, i.e. New Orleans. An approach to understanding local climate changes and water surpluses is discussed below. Through the data collection efforts it is hoped that predictions such as those related to water budgets will be verified.

a. Local Climate In Lac Des Allemands Area And Surplus Precipitation

The climatic input to the Upper Barataria Basin environment cannot be evaluated independently from the unique physical setting of the basin. This very brief physiographic overview of the basin has been culled mostly from a report by Gagaliana and van Beek (1970). Figure 8 shows that the upper portion of the basin drains mostly through Lake Des Allemands; the entire Barataria basin can be thought of as an estuary; and also as an interdistributary basin, within the ancient and modern deltaic complex of the Mississippi River system.

The Barataria Basin consists mostly of relatively poorly drained lowlands between two major distributaries of the Mississippi River delta complex. The present main channel of the Mississippi River, and associated natural levees, forms the eastern and northern margins of the basin, and an older and now abandoned main channel, Bayou Lafourche, and its associated levees forms

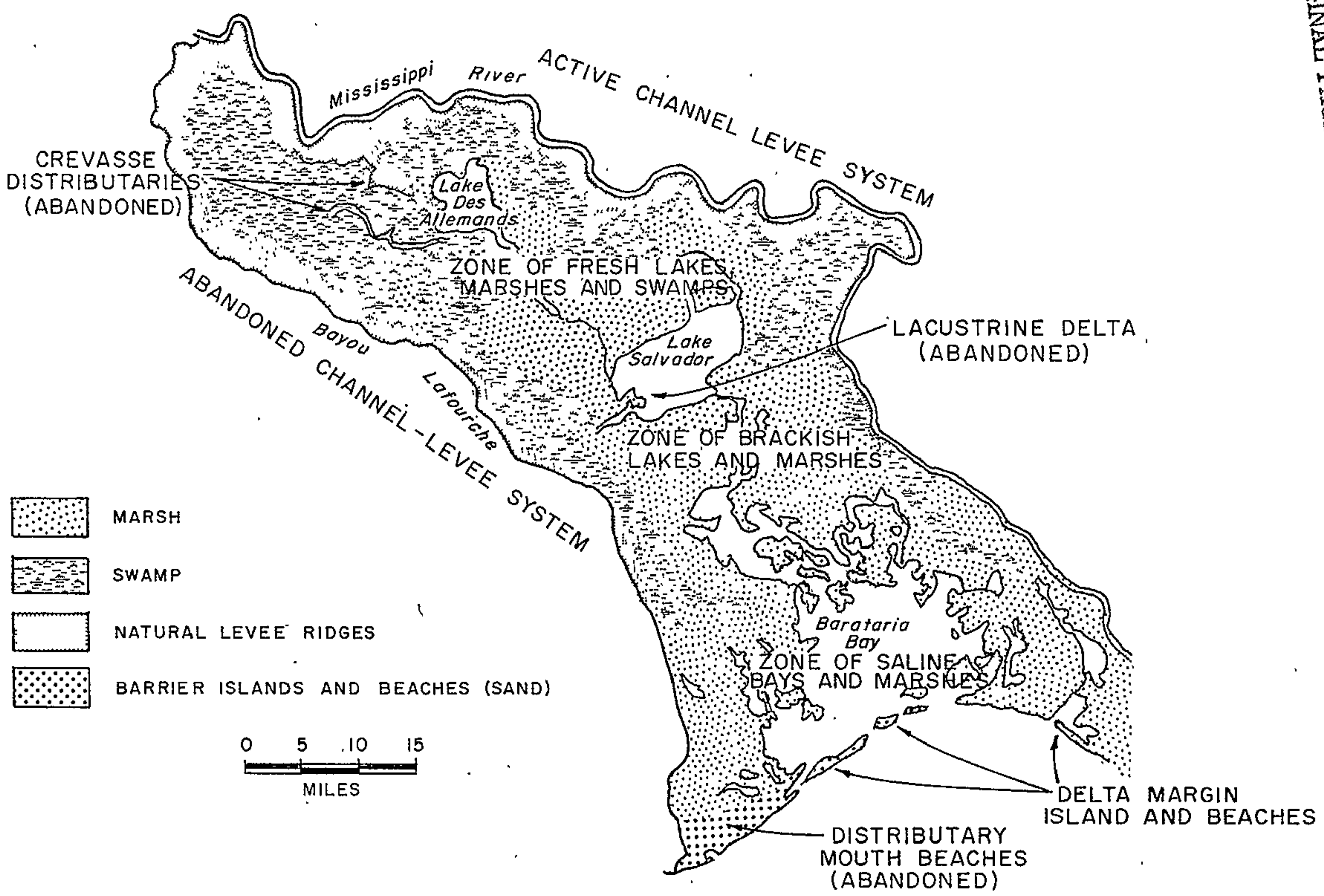


FIGURE 8 THE DES ALLEMANDS-BARATARIA BASIN, A MAJOR INTERDISTRIBUTARY ESTUARINE BASIN OF THE MISSISSIPPI DELTAIC PLAIN

the western boundary of the basin. The entire delta complex continues to subside slowly because of the enormous loading of river sediments dumped near the mounts of active distributaries of the river, but the natural and artificial levees of the main river channel prevent significant quantities of sediments from being distributed over the basin. As a consequence of the subsidence and lack of sediment supply, Gulf waters have gradually entered the basin, and the lower two thirds of the basin exhibits classic estuarine characteristics with mixing of fresh and saline waters in the marshes and open water bodies.

Figure 8 also shows that the upper basin is partially subdivided by abandoned crevasse distributaries; sediments associated with these crevasse distributaries built slightly higher ribbons of land which help to organize the drainage of the upper basin into sub-drainage units which can be recognized and evaluated independently. Agriculture, mostly sugar-cane production, is restricted to the higher and better drained natural levees and crevasse distributaries, and the center of the upper basin consists mostly of very poorly drained hardwood swamps. Within the upper portion of this interdistributary basin, the single most significant environmental parameter is probably water level in the swamps, and, of course, associated water quality.

The hydroclimatology of the upper basin can be organized within a framework of synoptic weather types and water budgets which are most useful for evaluation of water levels. All of the runoff within the upper basin is generated from surplus local precipitation which does not return to the atmosphere as evaporation or transpiration. Just a few synoptic weather types produce most of the precipitation. The water-budget methodology provides for a daily evaluation of the income, outgo, and storage of water within the basin, and the water-budget computations can be combined with the synoptic weather type evaluation. Water levels in the upper basin are also affected significantly by brisk and persistent winds; southerly winds drive Gulf water into the lower basin, and water levels in the upper basin tend to rise in response; conversely, strong and persistent northerly winds drive lower basin estuarine water into the Gulf, and upper basin water levels respond by falling. These strong and persistent winds can also be organized by the same synoptic weather types.

SYNOPTIC WEATHER TYPES

The broad spectrum of weather at the first-order station of the National Weather Service At Moisant Airport, New Orleans, has been classified into a small number of synoptic weather types in order to form an environmental climatic baseline for southeastern Louisiana; each type is representative of both the causal atmospheric circulation and its associated environmental response. Specifically, the daily weather map of the National Weather Service has been utilized to classify the weather at 0600 hours CST at New Orleans into 8 all-inclusive weather types. These synoptic types are Pacific High (PH), Continental High (CH), Frontal Overrunning (FOR), Coastal Return (CR), Gulf Return (GR), Frontal Gulf Return (FGR), Gulf Tropical Disturbance (GTD), and Gulf High (GH); the weather types and the methodology have been outlined in more detail by Muller (1976).

The observational data taken at Moisant Airport, recorded on an hourly basis, and published for every third hour, are then organized into a climatic calendar by fitting the data to the weather-map analysis of synoptic types. Table 2 illustrates a portion of the synoptic weather type calendar for New Orleans during January, 1973. This calendar lists the time of initiation of each weather type, hours of duration of each type, and the passage of warm and cold fronts. For example, the month opened with the FOR type persisting for

TABLE 2

SYNOPTIC WEATHER TYPE CALENDAR

NEW ORLEANS, LOUISIANA

JANUARY 1 - 20, 1973

Type	Date	Hour	Hours Duration
Frontal Overrunning	1	0000	54
warm-front passage	3	0600	
Frontal Gulf Return			6
cold-front passage	3	1200	
Pacific High			24
cold-front passage	4	1200	
Frontal Overrunning			21
warm-front passage	5	0900	
Frontal Gulf Return			21
cold-front passage	6	0600	
Frontal Overrunning			150
Continental High	12	1200	93
Coastal Return	16	0900	27

54 hours until a warm-front passage at 0600 hours on January 3. The warm front initiated the FGR type which lasted for only 6 hours when the PH type followed a cold-front passage. The PH type was in turn terminated 24 hours later by another cold front at 1200 hours on January 4 which introduced polar air and the FOR type.

The calendars and monthly summaries of climatological properties by snyoptic weather types provide climatic baselines from which inferences about environmental interactions may be drawn. Table 2 summarizes selected weather-type properties for 4 Januaries (1971-1974) and illustrates the contrasts among types. At 0600 hours, CST, in January, the table shows the orderly sequence of mean temperature in Fahrenheit degrees from the CH type as the coldest to the FGR type as the warmest. Both the dewpoint temperature and the relative humidity follow a similar progression. There is also a logical progression of mean wind directions given in azimuths from 01 to 36 representing 10° through 360°. Mean wind speeds are in knots, and the stronger winds associated with frontal activity are evident. Cloud cover is relatively high, except for the CH, PH, and GH types.

Table 3 also illustrates mean properties of each weather type at 1500 hours CST, at approximately the warmest time of the day on the average. The contrast between properties of the CH and FOR types, both normally representing cP air, are of special interest; environmental responses to these two weather types must be very different. Note also the low cloud cover associated with the PH, CH, and GH types, and the full cloudiness associated with the frontal types, FOR and FGR.

Table 4 illustrates mean properties for July, when the differences and distinctions of properties among synoptic weather types are much smaller than during winter. During July the GH and GR types dominated the synoptic

TABLE 3

MEAN PROPERTIES SYNOPTIC WEATHER TYPES

New Orleans, January 1971-1974

0600 CST	PH	CH	FOR	CR	GR	FGR	GTD	GH
No. Cases	8	17	37	8	30	18	0	5
Air Temperature	49	38	47	48	62	67	-	49
Dew Point Temperature	47	31	41	45	60	64	-	45
Relative Humidity	92	78	81	89	93	91	-	65
Wind Direction	34	04	01	12	14	17	-	35
Wind Speed	4	7	10	4	6	8	-	4
Cloud Cover	4	1	9	7	9	9	-	4
1500 CST								
No. Cases	8	19	33	9	30	20	0	5
Air Temperature	66	54	53	61	73	73	-	66
Dew Point Temperature	48	32	45	48	62	65	-	41
Relative Humidity	53	45	76	64	70	76	-	48
Wind Direction	32	36	01	07	16	19	-	30
Wind Speed	8	9	10	9	11	9	-	8
Cloud Cover	2	1	10	6	7	10	-	4

TABLE 4

MEAN PROPERTIES SYNOPTIC WEATHER TYPES

New Orleans July 1971-1974

0600 CST	PH	CH	FOR	CR	GR	FGR	GTD	GH
No. Cases	0	15	3	9	32	5	5	55
Air Temperature	–	73	73	74	75	74	76	76
Dew Point Temperature	–	70	68	72	72	72	72	72
Relative Humidity	–	88	84	95	89	94	88	90
Wind Direction	–	01	32	07	12	24	05	27
Wind Speed	–	4	6	7	4	4	4	4
Cloud Cover	–	6	10	5	6	7	5	5
1500 CST								
No. Cases	0	14	6	7	37	3	6	51
Air Temperature	–	88	81	82	85	78	84	88
Dew Point Temperature	–	70	72	73	73	71	71	73
Relative Humidity	–	55	74	77	73	79	67	63
Wind Direction	–	02	30	10	17	24	15	25
Wind Speed	–	8	8	10	7	5	10	7
Cloud Cover	–	6	9	7	8	10	6	7

calendars, and their associated properties were similar. The most significantly different weather type during July was the CH type, which tended to have slightly lower dewpoints, to be cooler at night and hotter during the daytime, and with less cloud.

Monthly precipitation between 1971-1974 at Moisant Airport by synoptic weather types is shown in Table 5; the table is organized in terms of mean monthly precipitation for the 4 years. During these 4 years, the FGR type and FOR accounted for 45 and 17 percent of the total precipitation; frontal precipitation, therefore, accounted for about two-thirds of the total rainfall. The GTD type, despite limited occurrences, accounted for another 13 percent, and the GR and GH types produced an additional 12 and 8 percent respectively. Perusal of the table also indicates distinct seasonal patterns of precipitation among the various types. The mean annual precipitation of 68 inches for these 4 years was above the long-term mean annual precipitation of about 58 inches.

WATER BUDGET METHODOLOGY

Fresh water inputs to the upper basin can be estimated by use of a modified version of the water-budget model originally developed by Thronthwaite (1948). Figure 9 will be utilized to outline in brief water budget components on a monthly basis for Baton Rouge between 1960 and 1967 (Muller and Larimore, 1975). Potential evapotranspiration (PE) is represented by the upper continuous curve, and PE can be defined as the maximum amount of evapotranspiration which would take place with a continuous vegetation cover and no shortage of soil moisture to the vegetation over a large region. Potential evapotranspiration is controlled primarily by solar radiation income, but in the absence of solar radiation data, Thornthwaite estimated PE on the basis of mean monthly

TABLE 5

MEAN MONTHLY PRECIPITATION BY SYNOPTIC WEATHER TYPES

NEW ORLEANS 1971-1974

IN INCHES

	J	F	M	A	M	J	J	A	S	O	N	D	Year	Per Cent
Pacific High	0	0.1	0	0.2	0	0	0	0	0	0	0	0	0.3	
Continental High	0	0.1	0	0	0	0.4	0.3	0	0	0	0	0	0.8	1
Frontal Overrunning	1.5	1.5	1.6	1.2	0.2	0.1	0.4	0.1	0.6	0.5	2.6	1.5	11.8	17
Coastal Return	0	0	0	0	0	0	0.2	1.1	0.4	0.2	0	0	1.9	3
Gulf Return	0.8	0.2	0.1	0.5	0.4	1.9	2.0	1.1	0.1	0.8	0.1	0	8.0	12
Frontal Gulf Return	2.5	3.8	5.4	2.9	4.2	0.4	0.1	0.7	1.0	1.6	2.5	5.5	30.6	45
Gulf Tropical Disturbance	0	0	0	0	0.8	0	0.2	0.7	7.5	0	0	0	9.2	13
Gulf High	0	0	0	0	0	2.4	1.9	1.4	0.1	0	0	0	5.8	8
All Types	4.8	5.7	7.1	4.8	5.6	5.2	5.1	5.1	9.7	3.1	5.2	7.0	68.4	

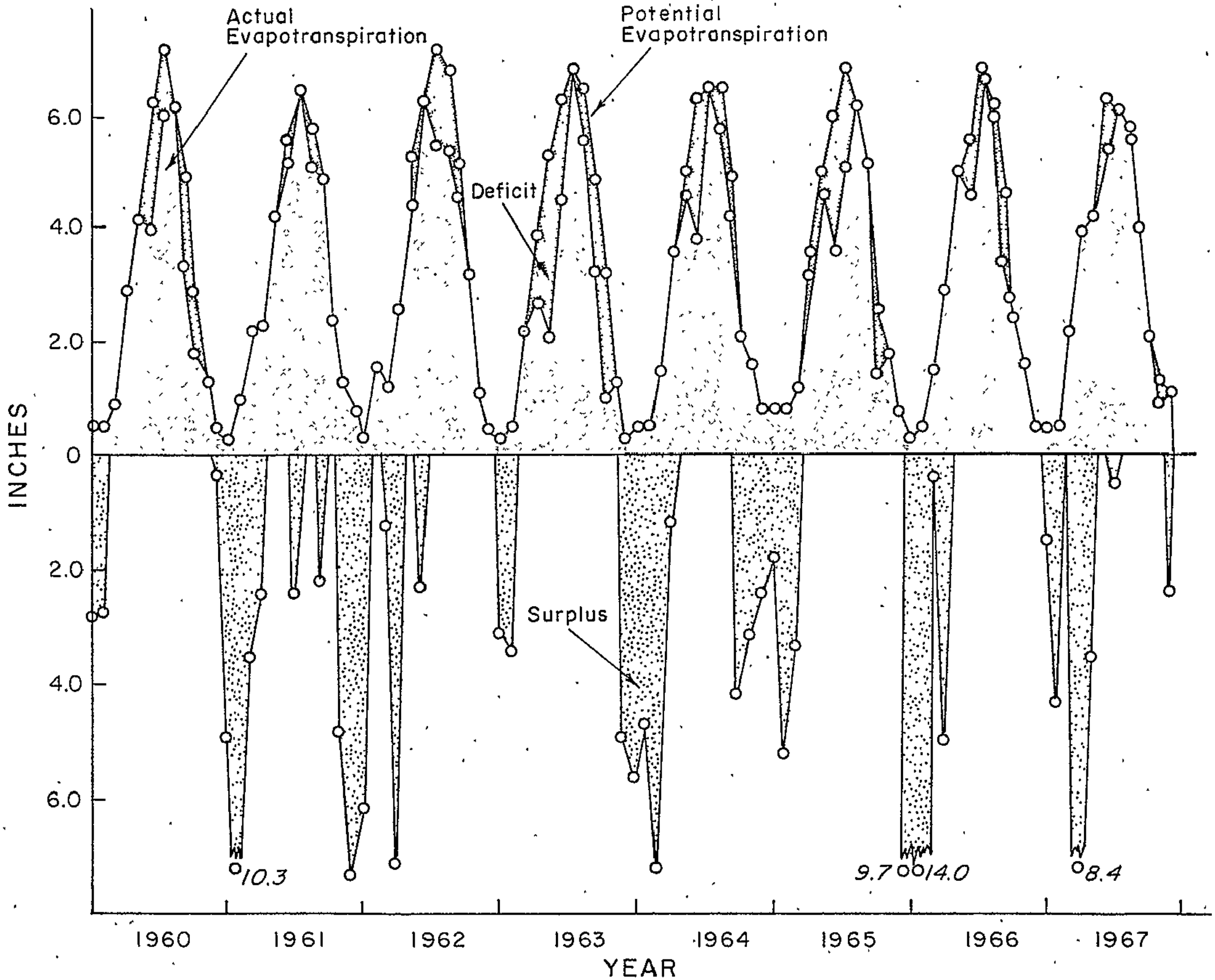


FIGURE 9 MONTHLY COURSE OF COMPUTED WATER BUDGET FACTORS AT BATON ROUGE, LOUISIANA, 1960-1967

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temperatures and daylength factors. For a daily water budget, daily maximum and minimum temperatures are utilized.

The horizontally ruled areas in Figure 9 represent actual evapotranspiration (AE). Since declining soil moisture inhibits actual evapotranspiration, AE is often less than PE. This is especially true for well drained soils in the vicinity of Baton Rouge during summer and autumn. When AE is less than PE, a deficit (D) is calculated, and it is assumed that plants begin to suffer from lower transpiration rates.

The surplus (S) is of most immediate concern to this study. Surplus is the "excess precipitation" after accounting for evapotranspiration losses and soil moisture recharge. Figure 1 illustrates that surpluses are greatest in winter and spring when precipitation is high and PE is low. Comparison of surpluses adjusted by a time lag to approximate calculated runoff and measured runoff for drainage basins in central and southern Louisiana indicate that the water-budget components are reasonably representative of environmental parameters in Louisiana (Muller & Larimore, 1975).

Michael Borengasser of the Department of Geography and Anthropology and the Center of Wetland Resources adapted a modified daily version of the Thronthwaite water-budget program for estimation of surpluses that generated runoff across the upper Barataria Basin (Yoshioka, 1971). Figure 10 shows the areas of the four sub-drainage units of the Upper Barataria Basin. Each sub-drainage basin was further subdivided into relatively well-drained uplands along natural levees and major crevasses, with most of these areas given over to agricultural, urban, and industrial landuses, and the poorly-drained swamp forests, marshes, and open water bodies. Separate water budgets were then calculated for uplands where the soil moisture storage capacity was assumed to average 6 inches, and

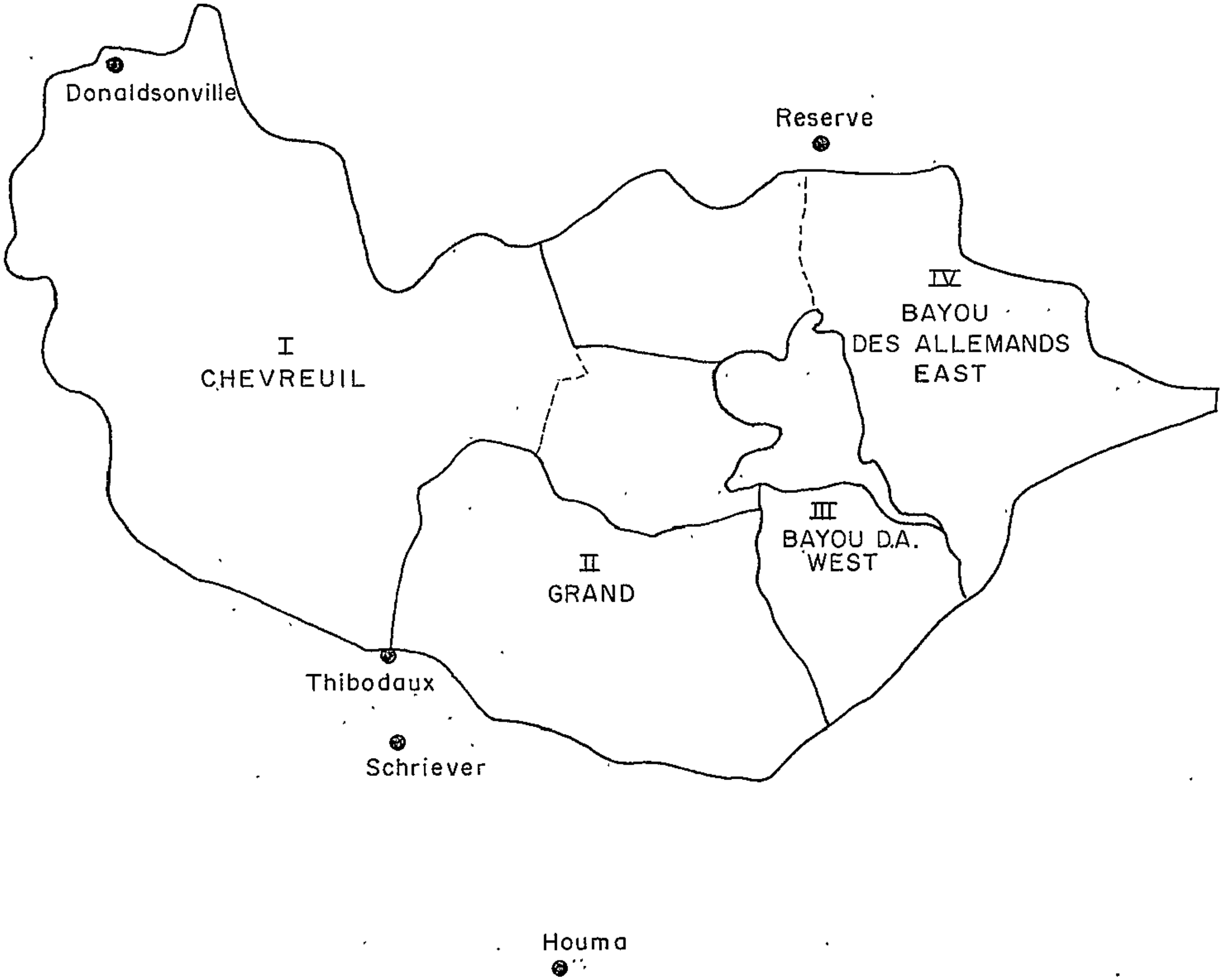

FIGURE 10 SUB-BASINS IN THE UPPER BARATARIA BASIN
LAC DES ALLAMANDS REGION

for the poorly drained areas and open water bodies where the supply of water for evaporation and evapotranspiration was assumed to be unlimited. On a daily basis, therefore, equation (1) gives the surplus for well drained areas, and equation (2) for poorly drained areas and open water bodies,

$$(1) \quad S = P - PE - \Delta ST,$$

$$(2) \quad S = P - PE$$

where S = surplus, P = precipitation, PE = potential evapotranspiration, and ΔST = the change of soil moisture storage. For the poorly drained areas, therefore, equation (2) assumes that AE will always equal PE, and that there will be no deficits. In actuality, there will be small deficits during prolonged dry spells.

There are almost no climatic stations within the Upper Barataria basin, and the sub-basin water-budget needed to be evaluated with temperature and precipitation data taken largely around the margins of the basin. For the Bayou Chevreuil sub-basin, for example, daily separate water budgets were calculated for Donaldsonville, Schriever, and Reserve; the locations of these cooperative stations of the National Weather Service are shown in Figure 10. This means that altogether there were 6 separate daily water budgets which contributed to the calculation of daily surpluses from the Bayou Chevreuil sub-drainage basin. For each cooperative station there were two budgets; one for the well-drained uplands, and the other for the poorly drained swamp forests and marshes. The basin-wide surplus from the well-drained natural levees was than prorated on the basis of the area of contribution of each of the cooperative stations, and this surplus (S) is given by equation (3), where S =

$$(3) \quad S_{basin} = 0.6DON + 0.2SHR + 0.2RES$$

the average basin-wide surplus from the levees, DON = daily surplus for Donaldsonville, SLH = daily surplus for Schriever, and RES = daily surplus for Reserve; these daily surpluses are derived from equation (1). Similarly, the basin-wide surplus from the poorly-drained swamps and marshes are derived from equation (3) with the individual station surpluses from equation (2). The computer program than transposes the daily surpluses in depth units equivalent to precipitation to volumetric units in terms of mean daily cubic feet per second generated over the Bayou Chevreuil sub-drainage basin.

ANALYSIS

As mentioned above, the single most important environmental parameter in the upper basin is water level in the waterways and swamps, and associated quality. Daily Water levels on Bayou Chevreuil for 1975 are shown in Figure 11; stages are given in feet, and the given stages represent levels approximately above mean sea level. It is generally assumed that water levels in adjacent hardwood swamps are closely correlated with the level of Bayou Chevreuil. The maximum and minimum levels absolute range for the year were from about 3.7 down to 1.3 feet, giving an extreme range of almost 2.5 feet. Levels tended to be high from late spring through summer and low during fall and winter. Although there is no apparent tidal effect at the gaging station on Bayou Chevreuil, seasonal water levels in the bayou may be affected slightly by higher global sea levels during summer and early autumn. However, precipitation was unusually high during the summer of 1975, and high water levels during this season are most likely associated with unusually large surpluses of freshwater.

Figure 12 shows daily synoptic weather types for Moisant Airport, New Orleans, about 35 to 40 miles east of the Upper Barataria basin, a weighted daily precipitation and surplus for Bayou Chevreuil, and mean daily water levels in Bayou Chevreuil. Water level changes are related to both the synoptic weather types and surplus precipitation from the water-budget calculations. The figure shows, for example, that decreasing water levels during January 4-5, 14-15, 20, and 23-24, are associated with the Continental High (CH) and Frontal Overrunning (FOR) synoptic weather types, when northerly winds tend to drive coastal waters southward to allow for additional drainage. Water levels rose especially during January 8 and 10-11 when 73 mm of precipitation

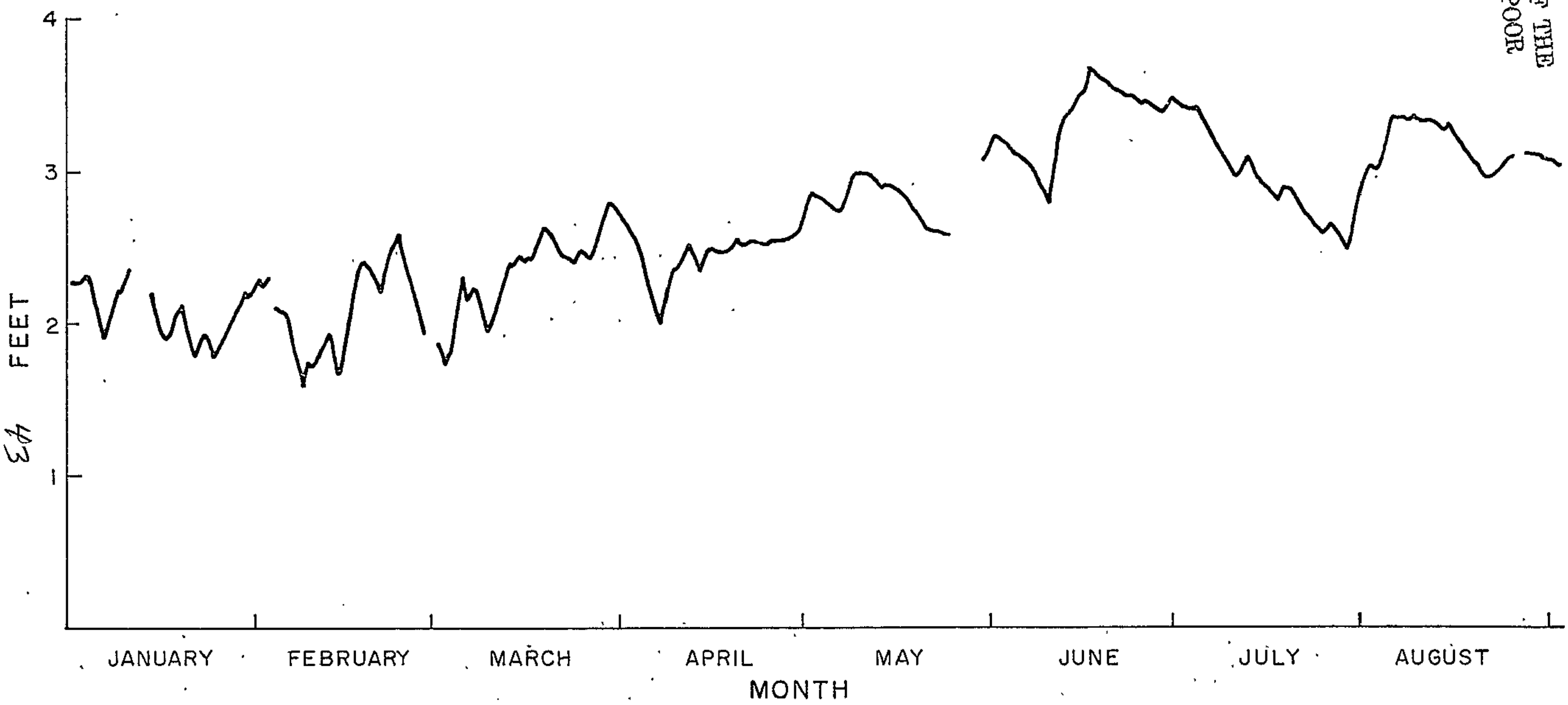

FIGURE 11 A DAILY STAGES AT BAYOU CHEVREUIN

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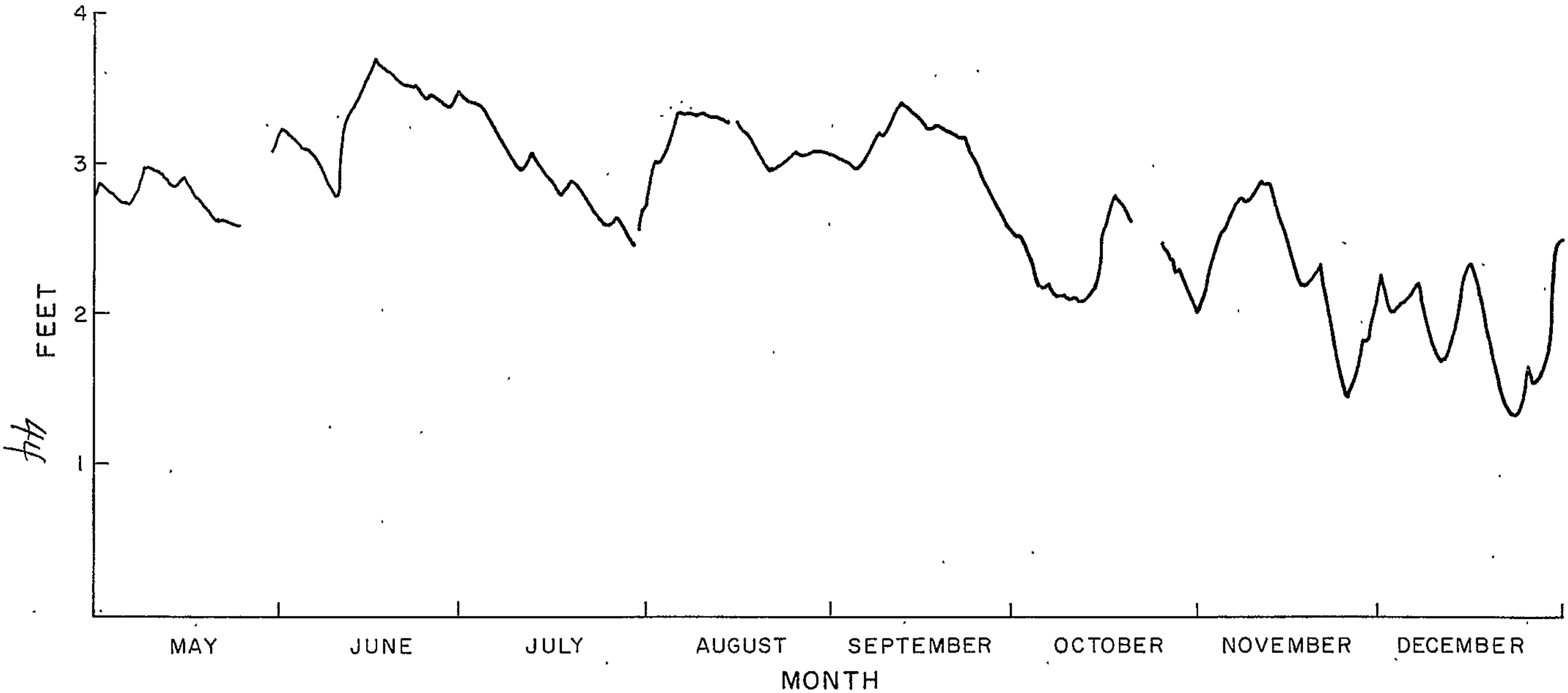

FIGURE II B DAILY STAGES AT BAYOU CHEVREUIN

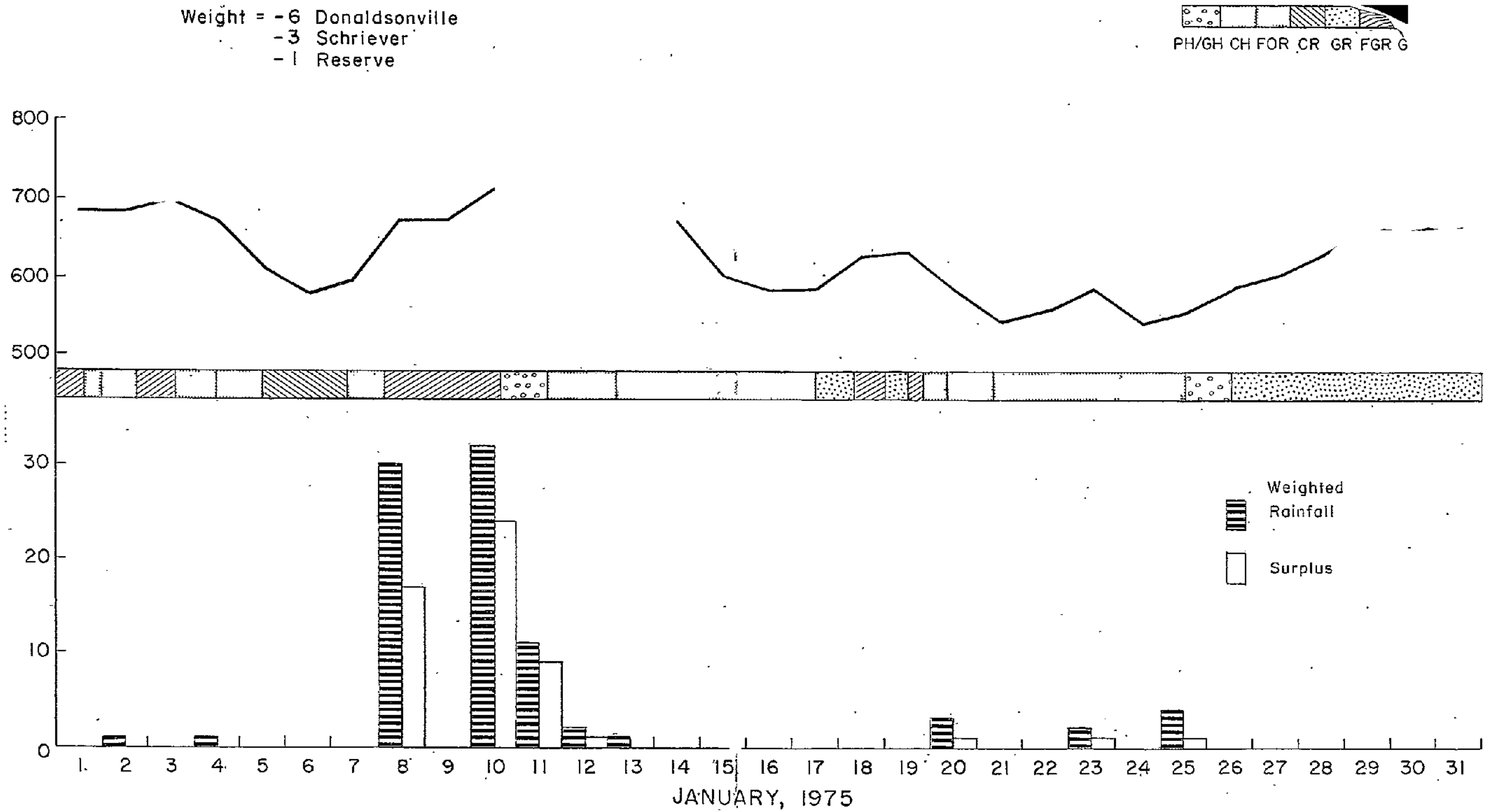

FIGURE 12 - A COMPARISON OF WEATHER TYPES AND WATER LEVELS IN THE LAC DES ALLEMANDS AREA

FOLDOUT FRAME 1 44a 44B FOLDOUT FRAME 2

generated about 50mm of surplus water available for runoff; data are unavailable for runoff; data are unavailable for high water levels on January 11-13. Water levels also tended to rise during the Gulf return (GR) and frontal Gulf return (FGR) synoptic weather types when southerly winds drive Gulf waters against the coastline; examples in Figure 5 include January 18 and 27-29. January 8-10 represents a mixed case with both the frontal Gulf return type and surplus water.

The realtionships between synoptic weather types, surpluses, and changing water levels in Bayou Chevreuil for January through June, 1975, are shown in Figure 13. This graph shows accumulated positive and negative water level changes during the six months by groupings of the synoptic weather types. For example, for the combination of the continental high (CH) and frontal overrunning types (FOR, without any surplus precipitation, daily water levels climbed 90 units (mm), but at other times dropped about 780 units; these two synoptic weather types are associated with northerly winds, and the expectation is that water levels should drop. When there were surpluses associated with the same two weather types, however, water levels rose 120 units, and dropped 130 units. The surpluses, therefore, tended to compensate the "normal" tendency for decreasing water levels.

The best comparison is now for the Gulf return (GR) and frontal Gulf return (FGR) types. Without surpluses, water levels rose about 540 units and fell 150 units. These two synoptic types are associated with southerly winds and rising water levels. When surpluses were present, water levels rose about 540 units, and fell only 40 units. Again, the ratio of rises to falls was greater with than without surpluses. The coastal return type (CR) was not associated with surpluses, and the Gulf high (GH), Pacific High (PH),

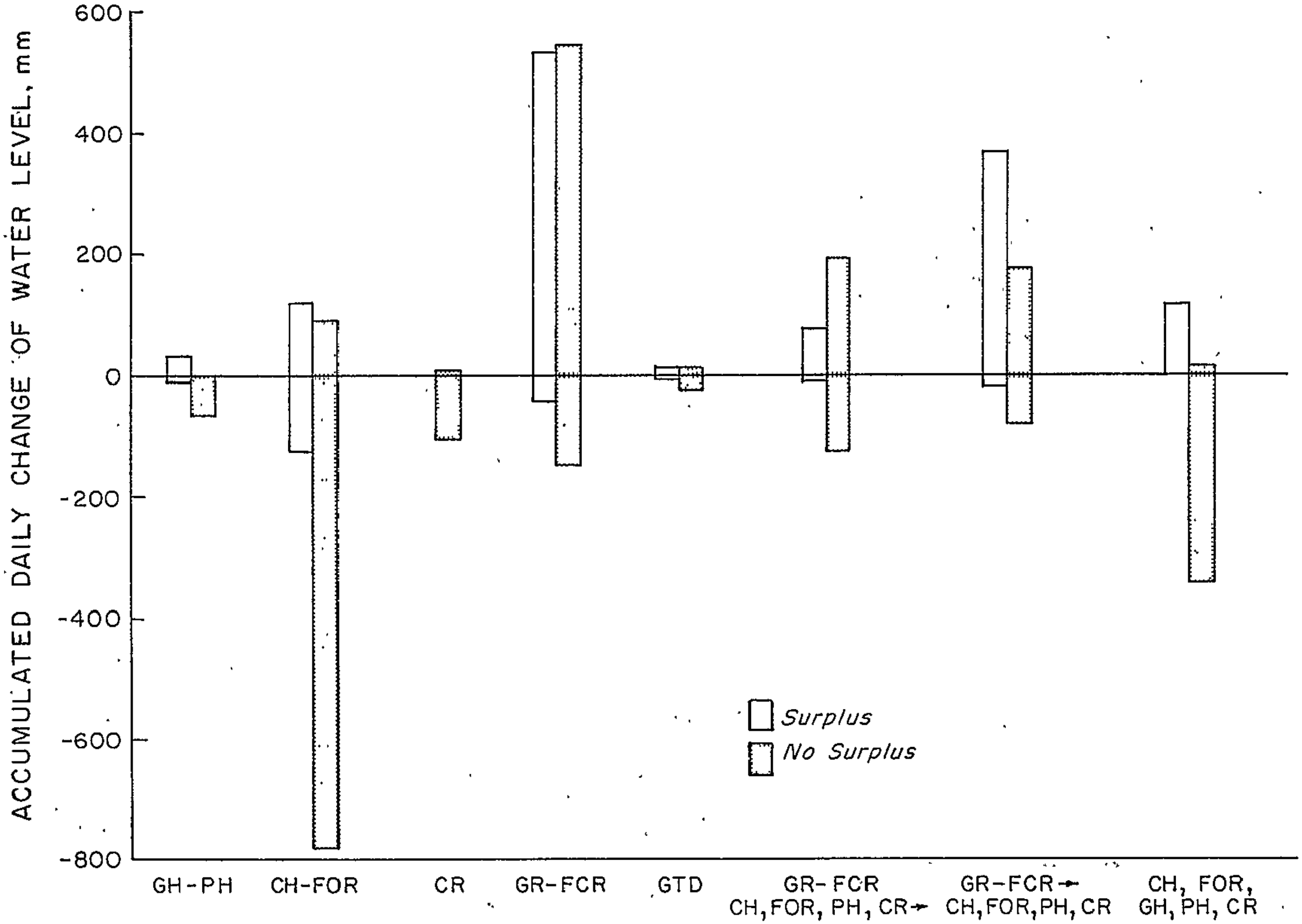

FIGURE 13 SYNOPTIC WEATHER TYPES AT NEW ORLEANS AND WATER LEVEL CHANGES AT BAYOU CHEVREUIL JANUARY-JUNE, 1975

and Gulf tropical disturbance (GTD) types did not occur frequently enough for significant conclusions.

The last three bar graphs on the right-hand side of Figure 13 show accumulated changes of water levels for days with more than one weather type. One grouping is for situations when the CH, FOR, PH, or CR types change to the GR or FGR types; these combinations generally represent warm-front passages, with winds veering from northerly through easterly to southerly. Without surpluses, the proportion of rising to falling water levels was nearly equal, but with surpluses, water levels rose more than they fell. The next combinations, the GR and FGR types changing to the CH, FOR, PH, and CR types represent mostly cold-front passages, with southerly winds becoming mostly northerly. Without surpluses, water levels rose more than they fell, but with surpluses, water levels rose 360 units and fell only 20 units. The last grouping represents a mixture of CH, FOR, GH, PH and CR types. During these types winds tend to be more notherly than southerly, so that without surpluses, water levels fell; with surpluses, in contrast, water levels tended to rise. This grouping is closely related to the CH*FOR types in terms of water-level responses.

Hence the synoptic weather type system and associated surplus precipitation tend to organize water-level changes in the Upper Barataria basin as indexed by Bayou Chevreuil. Correlations between weather types and water-level changes are only moderate, however, because of a number of factors. One is the 35 to 40 mile distance between the synoptic weather type baseline at Moisant Airport, New Orleans, and the basin; occasionally weather fronts may lie between the basin and Moisant Airport, or just offshore south of Barataria Basin. Responses in the basin under these situations will not be closely related to the weather type at Moisant Airport. Another is the very spotty nature of the rainfall; it simply not possible to predict basin-wide precipitation well from several stations. An additional factor is wind speed; the weather types tend to be associated with winds primarily from one direction, but wind speeds can be very variable. Obviously, water levels respond only to the stronger speeds.

b. Selected Aerial Photographs of Southeastern Louisiana for Classroom Use

For each science class (Jr. High School) Color Infrared Transparencies were supplied with a booklet. The imagery was supplied by the National Aeronautics and Space Administration through the Division of Engineering Research at Louisiana State University, Baton Rouge. All of the photos are of the general vicinity of the southeast coast of Louisiana. The individual frames were selected to provide a representative view of the natural environment and landuse in this rather unique area of the United States. Typical information and instructions contained in the booklets is presented below.

"These aerial photographs are routinely used for vegetation mapping, landuse planning, pollution detection and monitoring and a host of other uses tailored to the particular problems at hand. Color infrared film has advantages over normal color and black and white films which makes it suitable for special purpose work especially in vegetation monitoring. The near-infrared band of the electromagnetic spectrum is between .7 and .9 microns. Plants have a high degree of reflectance in this band and consequently show up in great detail, also slight variations in plants ability to reflect in this range causes changes in color on the film not readily recognized by the naked eye."

A general rule of thumb has interpretation of Color Infrared imagery is as follows:

1. Vegetation - bright red to red for healthy vegetation, pink to various shades of brown and green for diseased or dead vegetation.

2. Water - bright blue for sediment rich water, the darker the shade of blue, the less turbid and clearer the water.

3. Roadways, Urban Structures, Concrete - varies in color ranges depending on materials used in construction.

For interpretation of aerial photographs in general, a few factors should be taken into account.

1. Orientation - remember that you are looking straight down seeing everything from the top as in a plain view

2. Shape - the most obvious is usually the correct, but a change in perspective can fool the human eye.

3. Size - keep in mind relative size of objects and areas

4. Color - see above for color keys to infrared film

5. Pattern - spatial arrangement of objects may give a clue to their identification and whether natural or manmade land forms

6. Topographic Location - the relative location of one object or landform to another is many times useful in identification

7. Shadows - sometimes these are obscuring detail but they also offer a horizontal outline depending on the angle of the sun

8. Texture - the coarseness or smoothness may offer some key to identification, especially in vegetation.

Each frame has an accompanying sheet with a description of the landuse, general location, approximate scale, and pertinent questions.

A simple light table for viewing all types of transparencies can be constructed from materials available in most shops. The box is made of 1/2 inch plywood with 1 x 1 inch support posts. The 110 volt socket can be found at any hardware store and a 60 or 75 watt bulb is recommended. Holes can be drilled in the sides to prevent heat buildup. White translucent plexi-glass approximately 1/8 or 1/4 inch thick will provide a satisfactory viewing screen in place of ground glass. Please see the exploded diagram, figure 14 for details.

The following paragraphs are "exercises" prepared for each frame of imagery given to the classrooms.

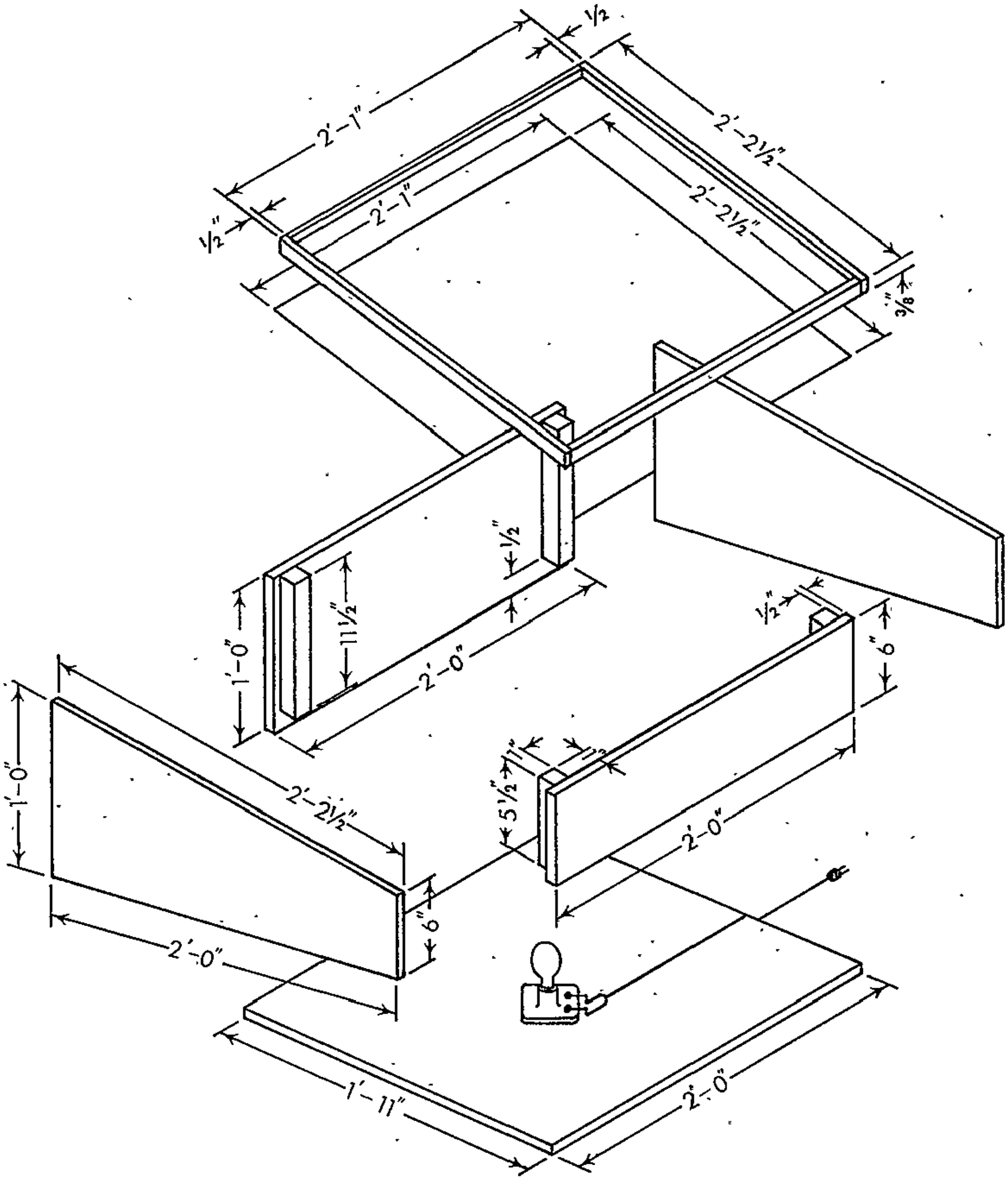

FIG. 14. SIMPLE DIAGRAM FOR CLASSROOM LIGHT TABLE

Vegetation Discrimination
Lake Boeuf Area, S.E. Louisiana Coast
Scale 1:6,000

Infrared film is useful in vegetation discrimination because of the different reflectance characteristics of the plants. The first photo shows marshland (predominatly grassland) and swampland (predominatly forest). The second photo is along the coast; the dominant vegetation is marsh grass. Compare this vegetation type with the bright red Black Mangrove (Avicenia nitida) fringing the islands in the third photo.

Exercises:

1. Using the interpretation keys in the introduction, compare and contrast the color, pattern, etc. in the photo. What similarities and differences are there?
2. What would be the best time of the year for using infrared aerial photography for vegetation discrimination? (Hint: Infrared film shows up dead and diseased plants as brown areas.)
3. Using tracing paper, outline the areas of different vegetation.

Spoil Banks
Morgan City, Lake Salvador
Scale 1:6,000

Spoil banks are the areas along dredged channels composed of the silt and sand removed from the bayou or canal bed. The spoil banks on these photos vary from very recently placed ones as a bright white splayed areas to older spoil banks with a cover of vegetation giving the area a mottled effect, or in the case of very old banks, a change in the vegetation along the bayou or canal usually showing a bright red color along the banks as opposed to more subdued tomes away from the water.

Exercises:

1. Why are bayous and canals dredged?
2. What use is being made of the new land created by the deposition of material making up the spoil banks?
3. Would these areas be high land or low land? Why?

Normal Color Photograph
Houma, Louisiana (6 copies)
Scale 1:6,000

This regular color film transparency of Houma, Louisiana shows how detailed an aerial photograph can be. This type of photo is used for community planning, traffic control and monitoring, zoning decisions and other land use applications.

Exercises:

1. What are the differences between this type of photograph and the infrared photographs?
2. Why would this type of photograph be more useful than the infra-red for this subject?
3. Knowing that 1 inch on the photo equals 6,000 inches on the earth (1:6,000) can you determine the length of some prominent building, bridge, or barge?
4. Can you find the shadow of the airplane that took these photographs?

Manmade Structures
Morgan City and Mathews, Louisiana
Scale 1:10,000

These photos have a variety of manmade structures ranging from residential districts to industrial sites. The distinctions between natural landforms and those constructed by man are generally easy to make. Manmade structures, such as canals are straight, even sided and usually show some symmetry in design. Natural landforms are more random and less likely to show order.

Exercises:

1. How many different manmade structures can you identify?
2. Some canals and roads look very similar, how can they be told apart?
3. How would aerial photographs aid a planner in deciding where a road, school, or industry might be built?
4. What are some of the types of transportation used in these areas?

Beech Ridges
West of Grand Isle, Louisiana
Scale 1:6,000

These near parallel ridges of high land above sea level alternating with troughs below sea level mark former positions of the coastlines. This area is being uplifted very gradually as a response to the gradual subsidence of the Mississippi River Delta area, this process is called isostatic adjustment. Another area in the state marking former beach lines is the Chenier Plain of the central and western coast.

Exercises:

1. Besides uplifting of the land what are some other causes of beaches being stranded?

2. Would this be a good place to build a town or city? Why or why not?

D. Support of Department of Interior, Office of Water Technology, Research Study

This project is divided into two work areas which required input based on the NASA program. The first is a study of the vegetation and wildlife in the study region where maps and support data for the field studies were obtained from infrared imagery. The second is in support of the Louisiana Joint Legislative Committee on Environmental Quality staff, who were to provide data services and assessment methodologies for the OWRT study.

a. Baseline and ecological study

This project is a part of the larger program wherein an assessment of the impact of energy related industrial activities in the Lac Des Allemands Basin will be accomplished. The portion of the main project undertaken in this study was mainly concerned with obtaining baseline ecological and botanical information for the undeveloped or non-cleared portions of the Basin. The results obtained in this base-line study will be used in developing the overall assessment methodologies and in determining weighting factors which will be used in assessment calculations.

The study area (the Lac Des Allemands Basin) is a somewhat triangular shaped mass of land north of Thibodaux, Louisiana. The area is bordered on the north by the Mississippi River Levee, on the southwest and south by Bayou Lafourche and on the east and southeast by La. Highway 90. Therefore the entire basin is essentially isolated from the surrounding areas. There are two lakes in the eastern portion of the basin. Lac Des Allemands is in the northeast portion of the basin and Lake Boeuf in the southeast portion of the basin. Both are shallow lakes with much seasonal fluctuation due to changes in seasonal rainfall.

The interior of the basin is composed of a cypress-tupelo swamp interwoven with many bayous canals and small drainages (sloughs). Encompassing the swamp is a perimeter of Bottomland Hardwood Type. This type grows at higher elevations and on areas less subject to flooding than the swamp type. The areas surrounding both lakes and much of the area to the southeast of Lake Des Allemands is covered by Fresh-Water-Marsh vegetation. Much of this vegetation is supported by floating organic mats, and only under periods of extremely low water level are these matts on solid ground. Along the dredged canals and bayous a distinctinve vegetation type grows on the spoil banks. These banks are .5 to 1.5 meters higher than the water level and free from flooding most of the year. The highest land in the area is in the developed type. This land is virtually free from flooding and in most cases has been cleared of forest for more than 50 years. It has been utilized for farming, urban development, industry, or highway construction. This land is mainly along the north and southwest boundaries and the cravasse along Highway 20 between Vacherie and Thibodaux.

Lac Des Allemands is the body of water which accumulates most of the runoff for the basin. It is a shallow fresh water lake with an average depth of about 2 meters. It is fairly level across the bottom with some relatively deep holes. It has approximately 15,360 acres of surface area. It is mainly surrounded by marsh leaving it very succeptable to wind action. This lake is drained by Bayou Des Allemands and empties into Lake Salvador.

Lake Boeuf is also a shallow fresh water lake. It is completely surrounded by marsh but much of it is closed to boat traffic due to dense growth of submerged vegetation. There are some clear channels through it but at different times of the year even these channels become clogged with water hyacinth and other floating vegetation.

The methods used in surveying this area and the preliminary results of the survey are contained in the following photographs. A major report on the project is being prepared for OWRT and deals with the impact of energy activities in the region. Copies of this report will be submitted to NASA upon completion of the total project.

Materials and Methods

A base map of the Lac Des Allemands Basin was prepared from recent (Winter 1974) black and white infrared photographs of the area. The base map had a scale of approximately 1:125,000. A transparency marked with one square centimeter grid system was positioned over the base map. A coordinate system was assigned to the grid and a systematic random sample of grid line intersections was selected.

Those intersections selected were used as reference points for the actual ground sample locations.

Individual parts of the infrared photo-mosaic of the area were enlarged and used to locate individual sample points. At each sample point a series of samples were taken. A one square meter (sq.m.) plot was established with a frame and used to measure the occurence of herbaceous vegetation. This sq.m. plot was further divided into quarters. Each herb occurring on the sq.m. plot was identified and recorded as occuring in either 1,2,3, or 4 quarters of the plot.

Using the same point center, a 15 sq.m. circular plot was established and all shrubs, woody vines and tree reproduction less than 4"d.b.h.* were identified and recorded as to number of stems occurring on the 15 sq.m. plot.

Again from the same point center, the trees were sampled using the point centered quarter method of overstory sampling (Cottam and Curtis, 1956). In this method, a variable sized plot is divided into quarters from a point. In each quarter the tree nearest the point center is identified and recorded as to species, d.b.h. and distance from point center. At each sample point, information on soil moisture, water depth at point center, height to bottom of overstory canopy, and density of overstory was taken. These values were

*d.b.h. = diameter of breast height; refers to the diameter outside the bark, measured at a point 4.5 feet above ground level.

estimated with the exception of water depth which was measured to the nearest 0.5 cm using a wooden meter stick.

To obtain a more accurate vegetation sample, 3 of these plot sets were sampled along a 60 meter transect at each sample point. The first set of plots was established at the sample point and the second and third were established at 30 meter intervals along a transect following a predetermined, randomly selected direction for the sample point.

Imagery and subsequent ground check were used to determine differences in dominant overstory vegetation.

Recent color infrared transparencies of the area were reviewed several times and different cover types delineated based on differences in color and texture.

On the imagery the marsh appeared as a smooth textured reddish color with fairly distinct boundaries. The swamp appeared as a mottled bluish-green color. The swamp gradually faded into the bottomland hardwoods which appeared as a rough textured mottled reddish region. The spoil banks, appeared as a rough textured reddish region but was fairly easy to distinguish from the marsh or swamp type. The developed land was smooth textured reddish or pinkish color with very distinct boundaries.

Ground checks were made to verify the degree of actual species difference and to determine distinctness of boundaries between various types. Since the photos had been taken in the fall, evergreen trees and areas of dense marsh and aquatic vegetation which were still alive and green were quite easily delineated. Along with information from consultation with personnel at the EROS center in Bay St. Louis, MS., the ground survey information was used to divide the basin dominant overstory types. These types were as follows: Cypress-Tupelo Swamp, Bottomland Hardwood, Marsh, Man-Made Spoil, and Developed Land (including agricultural and urban areas).

An aerial survey of the area was made in late spring. The flight was a low altitude, short duration flight in a Cesna 150. One major east-west transect and several short north-south transects were flown. The north-south transects were limited to the eastern side of the basin and in particular Lac Des Allemands and Lake Boeuf and the surrounding area. The flight was mainly a reconnaissance flight to obtain information not readily available from other sources. The noticable feature of the area was the high water level. Seventy-five to eighty percent of the area appeared inundated. Several large open areas were seen in the marsh. These openings were noted and their approximate locations drawn on 15 minute (min.) quadrangle maps during the flight. Canals and bayous rendered impassable by dense growths of water hyacinth were readily detected along with the extensive vegetation growth which occurs annually on Lake Boeuf. The timber types were not as readily detected from the air as from the infrared transparencies, but homogeneous stands of certain unidentified species were noted and located on the quadrangle maps. Also notices was the presence of several canals and right-of-ways not shown on the 1962 - 15 min. quadrangle maps of the area. Much of this information aided greatly in anticipating problems of transportation and location of points on the ground. Areas of special interest located during the flight were subsequently ground checked and described.

Results and Discussion

Most of the intensive vegetative survey was accomplished during June, July and August of 1975. A total of 79 starting points were sampled with three sample points associated with each starting point; 31 of the starting points were in the Swamp type, 31 were in the Bottomland Hardwoods type, 9 were in the Streambank type and 8 were in the Marsh type. Of the 4 types sampled, only the Marsh was free of trees or shrubs.

In the three types that did have trees there was an average of 484 trees per hectare (see appendix 1) with an average dbh of 26.1 cm. There were 24 different species of trees sampled on the plots. Of these the six most frequently recorded were Water tupeol (Nyssa aquatica), Drummond Red Maple (Acer rubrum var. drummondii) American elm (Ulmus americana), Green Ash (Frarinus pennsylvanica), Sweetgum (Liquidambar styraciflua) and Bladcypress (Taxodium distichum). Each of these made up more than 9% of the trees sampled. Together, they make up in excess of 66% of the trees of the area. The individual density of a particular species varies however from one vegetative type to another.

In the swamp type, the six species of highest relative density were Water tupelo, Drummond Red Maple, Baldcypress, Green Ash, Black Willow (Salix nigra) and Pumpkin Ash (Fraxinus tomentoso). Together these six species comprise over 90% of the trees sampled. There were 14 different species recorded from the swamp type, and an average of 516 trees/hectare.

In the Bottomland Hardwoods type a total of 21 different species were recorded. The six most commonly occurring species were American Elm, Sweetgum, Hackberry (Celtis laevigata), Drummond Red Maple, Swamp Dogwood (Cornus *drummondii*), and Green Ash. Together these species make up over 70% of the trees in the Bottomland Hardwood type. There was an average of 454 trees per hectare in the Bottomland Hardwood type.

In the spoil bank type 15 different species were recorded. The 6 most common species were: Black Willow, Drummond Red Maple, Water Tupelo, Green Ash, Boxelder (*Acer negundo*), and American Elm. Together these 6 species make up over 80% of the trees recorded on the Spoil Bank type. There was an average of 490 trees per hectare in the Spoil Bank type.

Several species were indigenous to specific types: Live Oak (*Quercus virginiana*), Tallow Tree (*Sapium sebiferum*) Swamp dogwood (*Cornus drummondii*), Willow Oak (Quercus phellos), Sweet Pecan (*Carya illinoensis*), and Sycamore (*Platanus accidentalis*) were recorded only on the Bottomland Hardwood plots. Honey Locust (*Gleditisia triacanthos*) was recorded only on the Spoil Bank plots.

Shrubs

The category of shrubs included shrubs, tree reproduction and saplings less than 10 cm dbh, woody vines extending into the midstory or overstory, or non-woody vines in the midstory of the stand. In short, it included all woody plants and non-woody vines in the midstory canopy, (See Appendix II). The seven most frequently occurring shrubs overall were Drummond Red Maple reproduction, Elderberry (*Sambucus canadensis*), Boxelder (*Acer negundo*), Swamp Dogwood, Green Ash reproduction, Palmetto (*Sabol minor*) and Virginia Willow (*Itea virginica*). The frequency or the occurrence of individual species of shrubs varied greatly with vegetative cover type. On the average there were 5080 stems per hectare or an average of 7.62 stems per 15 sq.m. plot.

The five most frequently occurring shrubs in the Swamp type were Drummond Red Maple, Green Ash reproduction, Virginia Willow, Bigleaf Snobell (Styrax granifolia) and Buttonbush (Caphalanthus occidentalis). In the Swamp there was an average of 5500 stems per hectare for an average of 8.25 stems per 15 sq.m. plot.

The five most frequently occurring shrubs in the Bottomland Hardwood type were Drummond Red Maple, Elderberry, Boxelder, Swamp Dogwood, and Palmetto (Sabol minor). In the Bottomland Hardwood type, there was an average of 5,200 stems per hectare or an average of 7.8 stems per 15 sq.m. plot.

The five most frequently occurring shrubs in the Spoil Bank type were Drummond Red Maple, Water Tupelo, Elderberry, Swamp Dogwood and Virginia Willow. In the Spoil Bank type there was an average of 3,260 stems per hectare or 4.9 stems per 15 sq.m. plot.

The Swamp type had a larger number of stems per hectare, but the Bottomland Hardwood type had more of a variety of species. Several species were indigenous to a particular vegetative type.

Although no shrubs were observed in the Marsh plots, a few shrubs were observed in the Marsh. They mostly belonged to the species Waxmyrtle (Myrica cerifera), and Buttonbush.

Herbs

The herbs are the largest and most variable group of plants. Sixty-four different species of herbs were recorded on the sample plots. There is much variation in the occurrence and frequency of occurrence of species among different vegetative types (See Appendix III). The largest variety in terms of numbers of species and the highest occurrence in terms of abundance of plants, was in the Marsh type. In the marsh 35 species were recorded. The species with highest relative frequency in Marsh was Maidencane (Panicum hemitomon).

It had a relative frequency of slightly over 20% in the marsh. However, it occurred only in the Marsh type as many of the other species. Of the 64 different species of herbs, only 5 occurred in all 4 vegetative types. These five are: Alligator Weed (Alternanthera philoxeriodes), Duckweed (Lemna minor), Lizard Tail (Saururus cernus), False nettle (Boehermia cylindrica var. cylindrica), and Royal Fern (Osmunda regalis var. spectabilis).

The six most frequently recorded herbs in the survey were: Duckweed, Dewberry (Rubus spp.), Lizard Tail, False Nettle, Poison Ivy (Rhus radicans) and Water Hyacinth (Eichhornia crassipes). Together these 6 species had a relative frequency of occurrence of slightly more than 45 per cent.

In the Marsh type, the four most frequently occurring herbs recorded were Maidencane, White Grass (Leersia hexandra), Bull Tongue (Sagittaria falcata), and Fern (Thelypteris palustris var halcana). Their combined relative frequency is over 52%.

The Swamp Type contained 29 species of which the four most frequently occurring were Duckweed, Water Hyacinth, Lizard Tail, and Water Lettuce (Pistia stratiotes). Their combined relative frequency was over 59%. Duckweed was the most frequently occurring herb in the swamp with 28% relative frequency.

The Bottomland Hardwood Type contained 27 species of which the four most frequently occurring were Dewberry, Poison Ivy, Lizard Tail, and False Nettle, The combined relative frequency of these four was slightly over 55%. The species with the highest relative frequency was Dewberry with 21%.

The Spoilbank Type contained 21 species of which the four most frequently occurring species were Dewberry, Elderberry, Peppervine (Ampelopsis arborea), and False Nettle. The combined relative frequency for the four was over 59%. Dewberry had the highest relative frequency, that of 21.5%.

These samples were taken during the summer months and the species composition and abundance of herbs would differ, perhaps greatly, if the samples had been taken at a different season. Also the water level during the sampling season was unusually high due to high rainfall. This also had an effect on species composition and abundance of herbs.

Appendix I - Trees

Table I - Nomenclature and Abundance of Trees Recorded in Des Allemands Basin

	Common Name	Scientific Name	# Stems	Relative density	# stems/ Hectare	Mean d.b.h.
1.	Water tupelo	Nyssa aquatica	128	15.09	73.1	31.29
2.	Baldcypress	Taxodium distichum	77	9.08	44.0	39.71
3.	Drummond Red Maple	Acer rubrum var. drummondii	122	14.39	69.7	18.07
4.	Black Willow	Salix nigra	70	8.25	39.9	25.56
5.	Green Ash	Fraxinus pennsylvanica	79	9.32	45.1	20.94
6.	Persimmon	Diospyros virginiana	6	.71	3.4	14.17
7.	Sweetgum	Liquidambar styraciflua	78	9.20	44.5	27.88
8.	American Elm	Ulmus americana	92	10.85	52.5	24.55
9.	Black Locust	Robina pseudo-acacia	3	.35	1.7	33.67
10.	Pumpkin Ash	Fraxinus tomentosa	13	1.53	7.4	23.85
11.	Hackberry	Celtis laevigata	54	6.37	30.8	29.17
12.	Eastern Cottonwood	Populus deltoides	5	.59	2.9	49.60
13.	Water Oak	Quercus nigra	21	2.48	12.0	22.24
14.	Swamp Black Gum	Nyssa sylvatica var. biflora	11	1.30	6.3	22.54
15.	Nuttall Oak	Quercus nuttallii	16	1.89	9.2	28.44
16.	Live Oak	Quercus virginiana	6	.71	3.4	77.33
17.	Tallow Tree	Sapium sebiferum	1	.12	.6	17.00
18.	Swamp Dogwood	Cornus drummondii	30	3.54	17.1	11.87
19.	Same as 13					
20.	Boxelder	Acer negundo	23	2.71	13.1	16.52
21.	Willow Oak	Quercus phellos	2	.24	1.2	12.00
22.	Sweet Pecan	Carya illinoensis	3	.35	1.7	34.67
23.	Honey Locust	Gleditisia triacanthos	1	.12	.6	13.00
24.	Obtusa Oak	Quercus obtusa	6	.71	3.4	17.33
25.	Sycamore	Platanus occidentalis	1	.12	.6	39.00

Appendix I
Table 2 - Distribution of Trees by Overstory Type in the Des Allemands Basin

	SPOIL BANK				BOTTOMLAND HARDWOODS				SWAMP			
SPECIES	# Stems	Relative Density %	# stems/ hectare	Mean d.b.h. cm.	# Stems	Relative Density %	# stems/ hectare	Mean d.b.h. cm.	# Stems	Relative Density %	# stems/ hectare	Mean d.b.h. cm.
1. Water tupelo	8	8	39.2	16.38					120	32.61	168.5	32.28
2. Bald cypress	2	2	9.8	62.50	2	.53	24	39.5	73	19.84	102.5	39.10
3. Drummond Red Maple	10	10	49.0	18.40	30	7.89	35.8	18.8	82	22.28	115.1	17.75
4. Black Willow	52	52	254.9	25.86	7	1.84	8.4	31.57	11	2.99	15.4	20.27
5. Green Ash	8	8	39.2	18.25	25	6.58	29.9	22.80	46	12.50	64.6	20.39
6. Persimmon					5	1.32	6.0	14.0	1	.27	1.4	15.00
7. Sweetgum	2	2	9.8	18.50	74	19.47	88.4	28.39	2	.54	2.8	18.50
8. American Elm	3	3	14.7	28.33	81	21.32	96.8	24.94	8	2.17	11.2	19.25
9. Black Locust					2	.53	2.4	42.0	1	.27	1.4	17.00
10. Pumpkin Ash	2	2	9.8	19.50					11	2.99	15.4	24.64
11. Hackberry	2	2	9.8	21.50	51	13.42	60.9	29.80	1	.27	1.4	12.00
12. Eastern Cottonwood	1	1	4.9	36.00	4	1.05	4.8	53.00				
13. Water Oak	2	2	9.8	24.00	19	5.00	22.7	22.05				
14. Swamp Black Gum					6	1.58	7.2	24.00	5	1.36	7.0	20.80
15. Nuttall Oak	2	2	9.8	16.00	12	3.16	14.3	32.58	2	.54	2.8	16.00

Appendix 1; Table 2 cont'd

SPECIES	SPOIL BANK # Stems	SPOIL BANK Relative Density %	SPOIL BANK # stems/ hectare	SPOIL BANK Mean d.b.h. cm.	BOTTOMLAND HARDWOODS # Stems	BOTTOMLAND HARDWOODS Relative Density %	BOTTOMLAND HARDWOODS # stems/ hectare	BOTTOMLAND HARDWOODS Mean d.b.h. cm.	SWAMP # Stems	SWAMP Relative Density %	SWAMP # stems/ hectare	SWAMP Mean d.b.h. cm.
16. Live Oak					6	1.58	7.2	77.3				
17. Tallow Tree					1	.26	1.2	17.0				
18. Swamp Dogwood					30	7.89	35.8	11.87				
19. Same as 13												
20. Boxelder	4	4	19.6	22.75	14	3.68	16.7	15.71	5	1.36	7.0	13.8
21. Willow Oak					2	.53	2.4	12.0				
22. Sweet Pecan					3	.79	3.6	34.67				
23. Honey Locust	1		4.9	13.0								
24. Obtusa Oak	1		4.9	14.0	5	1.32	6.0	18.0				
25. Sycamore						.26	1.2	39.0				

Appendix II - Shrubs
Table 1 - Nomenclature and Occurrence of Shrubs Recorded in Des Allemands Basin

Common Name	Scientific Name	Freq. of Occur.	Rel. Freq. of Occur.	Mean# Per Plot
1. Water Tupelo	Nyssa aquatica	7	1.28	1.57
2. Drummond Red Maple	Acer rubrum var. drummondii	124	22.59	5.23
3. Virginia Willow	Itea virginica	24	4.37	4.17
4. Green Ash	Fraxinus pennsylvanica	35	6.38	1.80
5. BigleafSnowbell	Styrax grandifolia	17	3.10	2.59
6. Rattan Vine	Berchemia scandens	11	2.00	2.36
7. Red-berried Moonseed	Cocculus carolinianus	7	1.28	2.14
8. Button Bush	Cephalanthus occidentalis	16	2.91	2.56
9. Palmetto	Sabol minor	30	5.46	2.50
10. Pepper Vine	Ampelopsis arborea	12	2.19	1.58
11. Elderberry	Sambucus canadensis	55	10.02	3.33
12. Swamp Dogwood	Cornus drummondii	36	6.56	1.83
13. Baldcypress	Taxodium distichum	4	.73	1.50
14. Pumpkin Ash	Fraxinus tomentosa	3	.55	2.00
15. Nuttall Oak	Quercus nutallii	10	1.82	1.80
16. Smilax	Smilax rotundifolia	6	1.09	4.83
17. Climbing Hempweed	Mikania scandens	4	.73	4.00
18. Mallow	Kosteletskya virginica	1	.18	4.00
19. Hackberry	Celtis laevigata	14	2.55	1.21
20. Boxelder	Acer negundo	37	6.74	1.86
21. Same As 12				
22. Deciduous Holly	Ilex decidua	5	.91	1.20
23. Sweetgum	Liquidambar styraciflua	11	2.00	2.36
24. Waxmyrtle	Myrica cerifera	4	.73	2.00

Common Name	Scientific Name	Freq. of Occur.	Rel. Freq. of Occur.	Mean# Per Plot
25.American Elm	Ulmus americana	17	3.10	1.71
26.Persimmon	Diospyros virginiana	3	.55	1.33
27.Trumpet creeper	Campsis radicans	3	.55	1.00
28.Water Oak	Quercus nigra	18	3.28	1.61
29.Live Oak	Quercus virginiana	1	.18	1.00
30.Obtusa Oak	Quercus obtusa	3	.55	1.67
31.Dewberry	Rubus spp.	2	.36	5.00
32.Hawthorn	Crataegus sp.	3	.55	1.67
33.Winged Elm	Ulmus alata	1	.18	1.00
34.Ladies Eardrops	Brunnichia ovata	6	1.09	1.67
35.Black Willow	Salix nigra	1	.18	2.00
36.Muscadine	Vitis rotundifolia	5	.91	1.20
37.Hickory	Carya sp.	3	.55	1.00
38.Cane	Arundinaria gigantea	1	.18	1.00
39.Switch Cane	A. tecta	1	.18	8.00
40.Obtusa Oak	Quercus obtusa	1	.18	1.00
41.Red Mulberry	Morus rubra	2	.36	1.00
42.Virginia Creeper	Parthenocissus quinquefolia	1	.18	1.00
43.Same As 7				
44. Poison Ivy	Rhus radicans	1	.18	1.00
45.Cross Vine	Anisostichus capreolata	1	.18	1.00
46.Swamp Privit	Foresteria accuminata	1	.18	2.00
47. Poke Weed	Phytolacca americana	1	.18	1.00
		549		

Appendix III

Table 1 - Nomenclature and Frequency of Occurrence of Herbs Recorded in Des Allemands Basin

COMMON NAME	SCIENTIFIC NAME	RELATIVE FREQUENCY IN B*	IN H*	IN S*	IN M*	TOTAL
1. Fern	Thelypteris palustris- var. halcana		.48	.52	7.63	1.84
2. Bull Tongue	Sagittaria falcata			.52	9.32	2.01
3. Maidencane	Panicum hemitomon				20.34	4.01
4. White Grass	Leersia hexandra				15.25	3.01
5. Cyperus #1	Cyperus virens				.85	.17
6. Alligator Weed	Alternanthera philoxeriodes	1.27	1.90	5.76	.85	2.84
7. Coontail	Ceratophyllum demersum			.52	.85	.33
8. Water hyacinth	Eichhornia crassipes	2.53		14.66		5.02
9. Red-berried moonseed	Cocculus carolinas	1.27		.52		.33
10. Duckweed	Lemna minor	5.06	1.90	28.27	3.39	11.04
11. Water lettuce	Pistia stratiotes			6.81		2.17
12. Lizard tail	Saururus cernus	3.80	10.00	9.95	2.54	7.69
13. Boneset	Eupatorium perfoliatum				1.69	.33
14. Yankee Weed	Eupatorium capillifolium				.85	.17
15. Snow-on-the-Mountain	Euphorbia				.85	.17
16. Pennywort	Hydrocotyle			.52	3.39	.84
17. Jewel Weed	Impatiens capensis				.85	.17
18. Roseau Cane	Phragmites communis				3.39	.67
19. Unknown Grass #1	Panicum gymnocarpon			4.71		1.51
20. Frogbit	Linmobium spongia			3.14	1.69	1.34
21. Flase Nettle	Boehmeria cylindrica var. cylindrica	10.13	9.05	1.57	3.39	5.69
22. Rush	Juncus effusus				2.54	.50

*B=Streambank; H=Bottomland Hardwood; S=Swamp; M=Marsh

COMMON NAME	SCIENTIFIC NAME	RELATIVE FREQUENCY IN B*	IN H*	IN S*	IN M*	TOTA
47. Ladies-eardrops	Brunnichia cirrhosa	1.27	.95			.50
48. (Smilax)	Smilax lanciolata		2.86	1.05		1.39
49. Cane	Arundinaria gigantea	1.27	3.33	4.19		2.68
50. Goldenrod	Solidago sp.		1.90			.67
51. Swamp lilly	Crinum americanum		.48	.52	.85	.50
52. Common Green Briar	Smilax rarundifolia		.48			.17
53. Pickrel Weed	Pontederia cordata			.52		.17
54. Sparganium	Sparganium americanum			.52		.17
55. Sawgress	Cladium jamaicense			.52		.17
56. Ludwigia	Ludwigia leptocarpa				.85	.17
57. Unknown Rush #1	Juncus sp.				.85	.17
58. Azolla	Azolla caroliniaia			.52	1.69	.50
59. Spirodela	Spirolella sp (polyrrhiza)				.85	.17
60. Same as 50						
61. Ebony Spleenworth	Asplinium platyneuron		.95			.33
62. Saw Green Briar	Smilax bonanox		.48			.17
63. Unknown Grass #5			.95			.33
64. Switch Cane	Arundinaria tecta		.48			.17
65. Green Dragon	Arisaema dracontium		.95			.33
66. Poke Weed	Phytolacca americana	3.80				.50

COMMON NAME	SCIENTIFIC NAME	RELATIVE FREQUENCY IN B*	IN H*	IN S*	IN M*	TOTA
23.Boehmeria	Boehmeria cylindrica var. Drummondiana	2.53		1.05	.85	.84
24.Fern #4	Woodwardia virginica	1.27			.85	.33
25.Pepper vine	Ampelopsis arborea	12.66	4.29			3.18
26.Elderberry	Sambucus canadensis	15.19	1.90			2.68
27.Creeping grass	Panicum commutatum	3.80	1.90			1.17
28.Dewberry	Rubus spp.	21.52	21.43			10.37
29.Climbing Hempweed	Mikania scandens	1.27	.48	1.05		.67
30.Day flower	Commelina diffusa	1.27				.17
31.Dodder	Cuscuta sp	2.53				.33
32.Elephants ear	Colocasia antiquorum			2.09	2.54	1.17
33.Fern #2 (Royal Fern)	Osmunda regalis var. spectabilis	5.06	2.86	.52	.85	2.01
34.Alternate leaf Alligator Weed	Polygonum punctatum		.95	6.28	1.69	2.68
35.Bed Straw	Galium sp.				.85	.17
36.Narrow leaf cattail	Typha angustifolia				.85	.17
37.Unknown Grass #2	Leersia sp.				1.69	.33
38.Deer Pea	Vigna repens				1.69	.33
39.Marsh Bindweed	Calystegia speium				.85	.17
40.Mallow	Hibiscus sp.			.52	1.69	.50
41.Parsley	Apium leptophyllum				.85	.17
42.same as 19						
43.Unknown Alligator Weed	Hygrophilia lacustris		4.76	1.57		2.17
44.Trumpet Creeper	Campsis radicans		4.76	.52		1.84
45.Poison Ivy	Rhus radicans	1.27	14.76			5.35
46.Rattan vine	Berchemia scandens	1.27	4.76	1.05		2.17

BIBLIOGRAPHY

Cottam, G. and J.T. Curtis, 1956, The use of distance measures in phytosociological sampling. Ecology. Vol. 37, NO. 3, pp. 451-460

Kolb, H. 1965, Audubon winter bird population study. Audubon Field Notes 19: 432-434

b. Support Services to OWRT (DOI) and Louisiana JLCEQ

Overlays produced for experimental digitizing equipment were compiled by Engineering Research personnel during the summer months of 1975. Maps showing landuse, waterways, and highways were drawn from USGS Topographic Quadrangles and U.S. Army Corps of Engineers Coastal Mosaics. The simple line drawings were of an area in southeast Louisiana beginning at Donaldsonville, Louisiana, where the channel of Bayou LaFourche and the Mississippi River diverge. The two waterways form the boundaries of the area down to State Highway 20 from Raceland to Luling. The area is an interlevee depression formed between the natural levees of Bayou Lafourche and the Mississippi River.

All of the overlays were drawn to a scale of 1:20,000. This scale was later reduced after digitizing. An attempt was made to up-date the variously dated Topographic Quadrangles and 1969 Coastal Mosaics with black and white infrared imagery taken in the Fall of 1974. Overall, little change was noted in the general category of landuse, except for areas in which oil exploration was ongoing.

Some of the problems involved in tracing the data from the maps and aerial mosaics were those defects inherent in the maps or photos. Scale differences between the maps and mosaics were difficult to correct, and scale changes within the aerial mosaics caused some problems as sophisticated equipment was not available for correction purposes. As a final measure, all of the updated data was transferred to a single set of aerial mosaics and the final tracings were taken from these completed photos.

The overlays were drawn so that they could be reassembled to show the combined landuse and physical features. Each junction of two or more lines was numbered to give a reference point for the digitizing equipment. The overlays were turned over to Don Harang and Don Whittinghill of the Joint Legislative Committee on Environmental Quality (JLCEQ) of the Louisiana State Legislature for further processing at the end of August 1975.

The purpose of this exercise was twofold: First, maps were prepared to support ground survey teams who were working on environmental studies for the Department of Interior. Secondly, the JLCEQ was supposed to use the products to develop "improved" data digitizing techniques, with the co-operation of personnel from the NASA/NSTL staff. The first objective was met with very satisfactory results from vegetation mapping efforts. We are not certain that our efforts for the JLCEQ were ever used nor have we seen the results of any of the proposed tasks which were supposed to be accomplished by JLCEQ. As a consequence, all digitizing efforts, mapping procedures, etc. for the DOI project were accomplished at LSU.

III. PERSONNEL PARTICIPATION

During this reporting period an interdisciplined team of professional staff and student assistants participated in the projects described previously. Other participation was indirect, such as the guidance of graduate students by major professors. The persons directly involved are listed below.

Professor Charles A. Whitehurst, Division of Engineering Research, Principal Investigator

Professor Ralph A. Kinney, Electrical Engineering

Associate Professor M. Bouvier, Electrical Engineering

Professor R. Muller, Geography

Lynwood Vaughn, Research Associate, Division of Engineering Research

Mike Milliet, Graduate Student, Mechanical Engineering

Bruce Roberts, Graduate Student, Mechanical Engineering

Anthony Blanchard, Graduate Student, Geography

JoAnna Lam, Graduate Student, Geography

Barbara Leuelling, Graduate Student, Geography

6 Undergraduates

APPENDIX A

A GEOGRAPHICAL APPROACH TO ROSEAU CANE IN LOUISIANA

Interim Report

Submitted to

M. Kristine Butera
NASA EARTH RESOURCES LABORATORY

REPORT ON "A GEOGRAPHICAL APPROACH TO ROSEAU CANE IN LOUISIANA"

Field research of Phragmites communis (roseau cane) commenced in May, 1975. Random stands of roseau cane located in the coastal parishes of Louisiana were chosen with the intention of illustrating the variety of conditions that Phragmites tolerates. Phragmites is locally abundant in seeps, along river flood plains, along canal banks, along shores of water bodies, and in ditches along roadsides. It is especially abundant in the Mississippi River delta.

Eleven of approximately twenty selected roseau cane sites have been studied. These include: T1 (North Pass) 1.2 miles north of North Pass on Rt. 55 between Lake Maurepas and Lake Ponchartrain; T2 (West Middle River) 1.5 miles west of W. Middle River bridge on Rt. 90 (Rigolets, La. 15' quad); T3 (Pearl River) on west bank of the Pearl River three miles north of Rt. 90 (Nicholson, La. 15' quad); T4 (Salt Bayou) on the Salt Bayou near junction of West Pearl River (Rigolets, La. 15' quad); T5 (Chef Menteur) on the roadside on Rt. 90 near Venetian Isles (Chef Menteur, La. 7.5' quad); T6 (Hingle) in the Mississippi River delta at the junction of Hingle Pass and Joe Brown Pass; T7 (Joe Brown Point) in the delta at the junction of Joe Brown Pass and Raphael Pass; T8 (Brant Island) in the delta at the eastern point of Octave Pass and Brant Bayou Pass; T9 (Mack's Pond) in the delta on Raphael Pass (T6-T9 all located on the East Delta, La. 15' quad); T10 (Petit lac des Allemands) approximately one mile southeast of Godchaux Canal (Des Allemands, La. 7.5' quad); and T11 (Bayou des Allemands) near Victor Canal (Des Allemands, La. 7.5' quad). Sites in the Sabine, Lacassine and Rockefeller Wildlife Refuges are also to be studied.

A morphological profile (100-300' long) of each site is being determined by use of transit equipment. These include water depth data at the time the profiles were established. (It is to be noted that water depth is subject to extreme fluctuations due to tidal influx--such variation is beyond the scope of this project.)

Soil samples have been extracted from each vegetation zone along each transect. Analyses of the soils will include grain size analysis, soil reaction (pH), percentage of moisture content, soluble salt content, percentage of organic matter, and nutrient status. Samples of vegetation along each transect (marsh elder, elephant ears, arrowhead, cattails, alligator weed) are being collected. Fifty pound samples of roseau cane have been cut from T2 (West Middle River), T3 (Pearl River), T7 (Joe Brown Point) and T10 (Petit lac des Allemands) for chemical analysis and comparison.

Water samples from each site have been extracted for determination of salinity tolerance of <u>Phragmites</u>. Height measurements have been noted. Those stands in the delta are the tallest--14-16' whereas those of the Pearl River area and those of the Bayou des Allemands area are only 10-12' tall. (June/July 1975). By using a meter sampling square, density measurements have been determined along both mixed and pure stands of roseau cane.

<u>PURE</u>

T2	West Middle River:	76 stalks roseau
T3	Pearl River:	134 stalks roseau
T6	Hingle:	48 stalks roseau
T10	Petit lac des Allemands:	72 stalks roseau
T11	Bayou des Allemands	85 stalks roseau

MIXED

T4	Salt Bayou:	roseau cane, 47 arrowhead, 27 pennywort, 5 (spartina patens, 30% coverage)
T5	Chef Menteur:	roseau cane, 14 marsh elder, 8 unidentified (composite), 21
T7	Joe Brown Point:	roseau cane, 21 elephant ear, 35
T8	Brant Island:	roseau, 95 elephant ear, 40
T9	Mack's Pond:	roseau cane, 100 elephant ear, 35

DELTA GROUND TRUTH (June 16-20, 1975)

Four test sites located in the Delta-Breton National Wildlife Refuge were chosen to determine the credibility of the classification system as calculated from the multispectral response of Phragmites communis. Attempts at mapping roseau cane from color infrared aerial photography at elevations of 30,000-60,000' have been unrevealing since it is difficult to distinguish roseau cane from other vegetation by color or height parameters at such altitudes. This difficulty can be more clearly understood when we realize roseau cane grows in small strips (5' x 10') and patches and that only in the delta does it assume expansive patterns that can more readily be detected.

Study in the delta was limited to Octave Pass, Brant Bayou Pass, and Raphael Pass because of the vehicle utilized and in order to not intrude upon a heronry. Furthermore, the study of these four sites includes the following:

(1) to illustrate the field research of roseau cane;

(2) to determine other vegetation in association with roseau cane;

(3) to suggest what threshold limit on the Gaussian distribution curve for the multispectral response of roseau cane proves most accurate; and

(4) to seek the possibility of separating multispectrally between roseau cane and other vegetation during another season.

FIELD RESEARCH

The four sites located in the delta are: Hingle (T6) at the junction of Hingle Pass and Joe Brown Pass; Joe Brown Point (T7) at the junction of Joe Brown Pass and Raphael Pass; Brant Island (T8) at the eastern point of Octave Pass and Brant Bayou Pass, and Mack's Pond (T9) on Raphael Pass, all located on the East Delta, La. 15' quad (attached). At these sites water and soil samples were taken and water depth measured. Height and density measurements of the roseau cane were recorded; vegetation samples were selected.

VEGETATION

A pure stand of roseau cane was found at Hingle (T6). The remaining three sites included elephant ear as a major understory vegetation.

Most commonly roseau cane appears as a pure stand or mixed with elephant ears. Occasionally it is associated with marsh elder and grasses. Distinct bands of other vegetation form on the seaward side of roseau cane stands--roseau cane, a band of elephant ears, a band of water hyacinth, and finally a band of duck potato. (Figure 1). The following photographs are representative of conditions in the delta at specific sites.

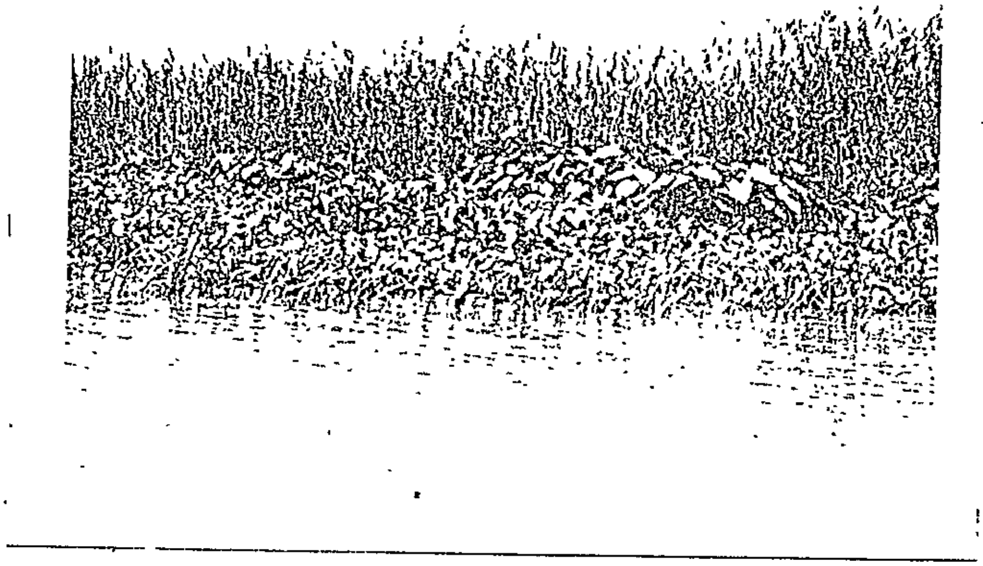

Fig. 1 - Raphael Pass - illustrating banding of vegetation, roseau cane in background, elephant ear, water hyacinth, duck potato.

Fig. 2 (T7 Joe Brown Point). Relative height of roseau to elephant ears. Person on right is 6'5. Roseau cane is 14-16' tall.

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OVERSIZED

ORIGINAL PAGE

CASE FILE