CHENIER PLAIN REGION ECOLOGICAL CHARACTERIZATION:

A Habitat Mapping Study

A USER'S GUIDE TO THE HABITAT MAPS

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PREFACE

The purpose of the Chenier Plain Region habitat mapping study is to compile a set of habitat maps using the most recent aerial photography (National Aeronautics and Space Administration [NASA] 1978) for reference in coastal planning, management, and permit evaluation. The User's Guide to the Habitat Maps is to aid the user of the habitat maps through clarification of labels and terms and a discussion of habitat map interpretative and cartographic processes.

This project was conducted under contract DNR-21910-431C-81-01. Funding was provided by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration (NOAA).

The 53 Chenier Plain habitat maps for 1978 may be examined in the offices of the Louisiana Coastal Resources Program, Coastal Management Section, Baton Rouge, Louisiana. A sample copy of one of the habitat maps, reduced by 58%, follows this page.

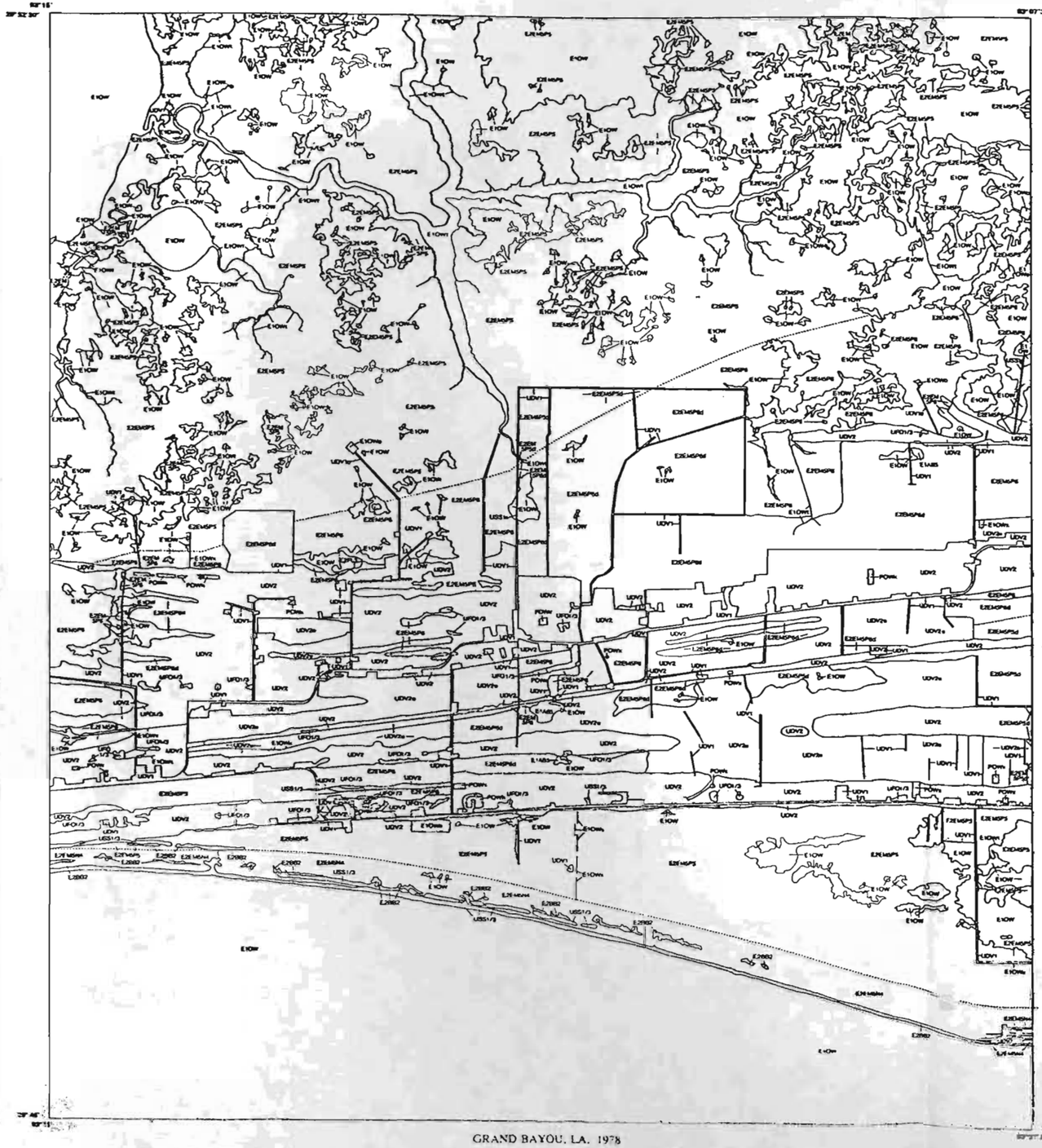
Any questions regarding the habitat maps, the user's guide, and the measurement of habitats should be directed to: Director, Louisiana Coastal Resources Program, Louisiana Department of Natural Resources, Coastal Management Section, P.O. Box 44396, Baton Rouge, Louisiana 70804.

The habitat maps should be cited:

> Wicker, K. M., M. DeRouen, C. Dixon, K. Meyer-Arendt, D. O'Connor, N. Sarwinski, K. Young, F. Zeringue (1981). The Chenier Plain Region Habitat Mapping Study. 53 maps. Louisiana Coastal Resources Program, Louisiana Department of Natural Resources, Baton Rouge, Louisiana.

The User's Guide to the Habitat Maps should be cited:

> Wicker, K. M. (1981). Chenier Plain Region Ecological Characterization: A Habitat Mapping Study. A User's Guide to the Habitat Maps. Louisiana Coastal Resources Program, Louisiana Department of Natural Resources, Baton Rouge, Louisiana.



CHENIER PLAIN REGION
HABITAT MAP

HABITAT MAP SYMBOLS

SYSTEM AND SUBSYSTEM

 # SYSTEM
+ subsystem

M MARINE
1 subtidal
2 intertidal

E ESTUARINE
1 subtidal
2 intertidal

P PALUSTRINE
— no subsystem

R RIVERINE
1 tidal
2 lower perennial
3 upper perennial
4 intermittent

L LACUSTRINE
1 limnetic
2 littoral

U UPLAND
— no subsystem

CLASS AND SUBCLASS

 # CLASS
+ subclass

AB AQUATIC BED
1 submergent algal
2 submergent vascular
3 submergent moss
4 floating-leaved
5 floating
6 unknown submergent
7 unknown surface

BB BEACH/BAR
1 cobble-gravel
2 sand/shell

EM EMERGENT
1 persistent
2 nonpersistent
3 narrow-leaved nonpersistent
4 broad-leaved nonpersistent
5 narrow-leaved persistent
6 broad-leaved persistent

FL FLAT
1 cobble/gravel
2 sand/shell
3 mud
4 organic
5 vegetated pioneer
6 vegetated non-pioneer

FO FORESTED
1 broad-leaved deciduous
2 needle-leaved deciduous
3 broad-leaved evergreen
4 needle-leaved evergreen
5 dead
6 deciduous
7 evergreen

OW OPEN WATER
unknown bottom

RF REEF
1 coral
2 mollusc
3 worm

RS ROCKY SHORE
1 bedrock
2 boulder
3 vegetated non-pioneer

SB STREAM BED
1 cobble-gravel
2 sand
3 mud
4 organic

SS SCRUB/SHRUB
1 broad-leaved deciduous
2 needle-leaved deciduous
3 broad-leaved evergreen
4 needle-leaved evergreen
5 dead
6 deciduous
7 evergreen

UB UNCONSOLIDATED BOTTOM
1 cobble/gravel
2 sand
3 mud
4 organic

DV DEVELOPED
1 urban-residential/commercial/industrial
2 agriculture/pasture/mowed grasslands
3 unvegetated land/spoil/disposal area

GR GRASSLAND

WATER REGIME MODIFIERS

NONTIDAL
A temporary
B saturated
C seasonal
D seasonal/well-drained
E seasonal/saturated
F semipermanent
G intermittently exposed
H permanent
J intermittently flooded

NONTIDAL COMBINED
X intermittently exposed-permanent (G, H above)
W intermittently flooded-temporary (J, A above)
Y saturated-semipermanent (B, C, D, E, F above)

TIDAL
L subtidal
M irregularly exposed
N regular
P irregular
R seasonal
S temporary
T semipermanent
V permanent

NONTIDAL AND TIDAL
U unknown
K artificial

WATER CHEMISTRY MODIFIERS

COASTAL SALINITY MODIFIER
1 hyperhaline
2 euhaline
3 mixohaline (brackish)
4 polyhaline
5 mesohaline
6 oligohaline
— fresh

INLAND SALINITY MODIFIER
7 hypersaline
8 eusaline
9 mixosaline
— fresh

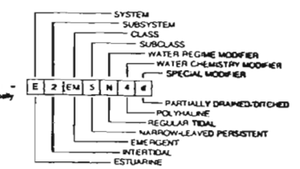
pH FRESH WATER MODIFIER
a acid
i circumneutral
i alkaline

SPECIAL MODIFIERS

OTHER MODIFIERS
b beaver
d partially drained/ditched
i farmed
n reclaimed wetland
o diked/impounded
r artificial
s spoil
x excavated
o oil, gas/mineral
t tidal
p beach
w lowed, standing water
m lowed, managed water levels

SOIL MODIFIERS
g organic
m mineral

Explanation of Habitat Map Symbols:



Boundary Legend:

- COASTAL ZONE: LOUISIANA ACT 361 of 1978, Amended by Act 165 of 1979, OFFSHORE STATE-FEDERAL DEMARCATION LINE
- HYDROLOGIC UNITS
- STATE
- PARISH
- MARSH ZONES: 1978 SALINE-BRACKISH-WATER-INTERMEDIATE/FRESH

Special Note:

The habitat map series of the Louisiana Chenier Plain Region is dated 1978. These maps are designed to be used with USGS topographic series maps, 7.5-minute quadrangles and orthophotoquads at a 1:24,000 scale. The inland extent of the coastal zone is that which was established by Legislative Act 361 of 1978 as amended by Act 665 of the 1979 Louisiana State Legislature, Regular Session. The offshore boundary is the State-Federal demarcation line. The two hydrologic units in the map series are similar to those shown in Chabreck (1972) but are drawn to approximate the actual hydrologic basin divides.

This document was produced by microscopic analysis of high-altitude aerial photographs at a scale of 1:24,000 as well as other sources of information. Habitats were identified on the photographs based on vegetation, visible hydrology, and geography in general accordance with Classification of Wetlands and Deep Water Habitats of the United States, Cowardin et al. 1979. Wetland designations may differ in some cases from those of National Wetland Inventory due to different mapping conventions and different qualities of photography used. Where necessary, new habitat categories were added to label non-wetland areas and to designate man-made habitats. The aerial photographs typically reflect conditions during the specific year and season when they were taken. In addition, there is a margin of error inherent in the use of the aerial photographs. Thus, a detailed, on-the-ground, and historical analysis of a single site may result in a revision of the wetland boundaries established through photographic interpretation. Also, some small wetlands and those obscured by dense forest cover may not be included in this document.

Federal, State, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this study. There is no attempt, in either the design or products of this study, to define the limits of proprietary jurisdiction of any Federal, State, or local government or to establish the geographical scope of the regulatory programs of governmental agencies. Persons intending to engage in activities involving modifications within or adjacent to wetlands are advised to seek the advice of appropriate Federal, State, or local agencies concerning specific agency regulatory programs, and proprietary jurisdictions that may affect such activities.

Major Habitat Map Sources:

Chabreck, R. H. and G. Linscombe. 1978. Vegetative type map of the Louisiana coastal marshes. Louisiana Wildlife and Fisheries Commission, Baton Rouge, LA.

NASA, Flight Request #6754 (Flanders, EPA), Occasion B, 9-10-75, 1978. Color infrared, uncontrolled prints, 1:24,000.

Triton Research, Inc. 1865-1958 ©1954. Black and white controlled mosaics, 1:24,000. San Antonio, Texas.

U.S. Geological Survey. Topographic Quadrangle Maps, 1:24,000 and 1:62,500.

prepared for: The Louisiana Department of Natural Resources for the purpose of carrying out the requirements of the Louisiana Coastal Zone Management Program under the authority of Act 361 of 1978. This project was financed through a grant provided under the Coastal Zone Management Act of 1972, as amended, which is administered by the U.S. Office of Coastal Zone Management, National Oceanic and Atmospheric Administration.

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SCALE 1:24,000

0 1 2 km

0 1 mi

0 2000 ft

GRAND BAYOU, LA. 1978
213C

ACKNOWLEDGEMENTS

Preparation of the habitat maps and user's guide for the Chenier Plain Region habitat mapping study enlisted the services of people from the Department of Natural Resources, Coastal Management Section, and Coastal Environments, Inc. We especially thank Joel Lindsey, John Glenn, and Neil Paterson, with the Louisiana Department of Natural Resources, Coastal Management Section, for providing the funding and guidance which made this project possible.

Within Coastal Environments, Inc., the following people contributed to this study:

* Air photo interpretation, field checking, habitat planimetering, and final map drafting were performed by a team consisting of K. Wicker, M. DeRouen, C. Dixon, K. Meyer-Arendt, N. Sarwinski, K. Young, and F. Zeringue.

* Data compilation and transferral to computer tape were performed by J. van Beek, D. O'Connor, and T. Johnson.

* Drafting of illustrations for the user's guide was done by C. Latiolais, K. LeBlanc, and N. Sarwinski.

* Typing of the final report was done by S. Hemphill.

* S. Pendergraft edited and compiled the final report.

CHAPTER I: INTRODUCTION

The Chenier Plain Region habitat mapping study identifies and measures habitats in southwestern Louisiana for 1978. This project is formulated after the preceeding U.S. Fish and Wildlife Service (FWS) Mississippi River Deltaic Plain Region habitat mapping study (Wicker et al. 1980; Wicker 1980), and completes the 1978 interpretation of coastal Louisiana lying within the Louisiana Coastal Zone.

The study area is located in coastal Louisiana south of 30° 07' 30" N latitude and between 92° 07' 30" and 94° W longitude. Unlike the previous mapping project (Wicker et al. 1980) which only interpreted habitats within the Louisiana Coastal Zone, this study interpreted the entire topographic map unit containing the Coastal Zone boundary, including areas north of the boundary line. The Coastal Zone boundary for Louisiana is defined by Act 361 as amended in 1979 and 1980 (Figure 1; Appendix 1) (Louisiana Department of Transportation and Development [LDOTD] 1980). The offshore boundary is the three-mile State-Federal demarcation line (U.S. Department of Interior [USDI], Bureau of Land Management [BLM] n.d.) (Figure 1). The eastern extent of the Chenier Plain study area is the western border of Hydrologic Unit VII, and the western limit is the Louisiana-Texas State boundary which is also the western border of Hydrologic Unit IX. The Chenier Plain Region contains two hydrologic units (VIII and IX). These are similar in location to those designated by Chabreck et al. (1968) and Chabreck (1972), but in this study they are more clearly defined by topographic features, such as natural and artificial levees and roads, which represent definite water drainage divides. These unit divides have also been extended north of the marshlands to the northern limits of the study area (Figure 1; Appendix 2).

The Chenier Plain, consisting of recent sediments overlying unconformably the eroded surface of the Prairie Formation, emerged concurrently with the development of the Mississippi River Deltaic Plain (Gould and Morgan 1962). The sediments have a minimal thickness along their interface with the Pleistocene Prairie Terrace, the northern boundary of the Chenier Plain, and range from 20 to 40 ft (6 to 12 m) thick along the present Gulf of Mexico shoreline (Gould and Morgan 1962). During periods of Mississippi River Delta progradation in the western portion of the Deltaic Plain, fine-grained sediments were transported west to the Chenier Plain by littoral

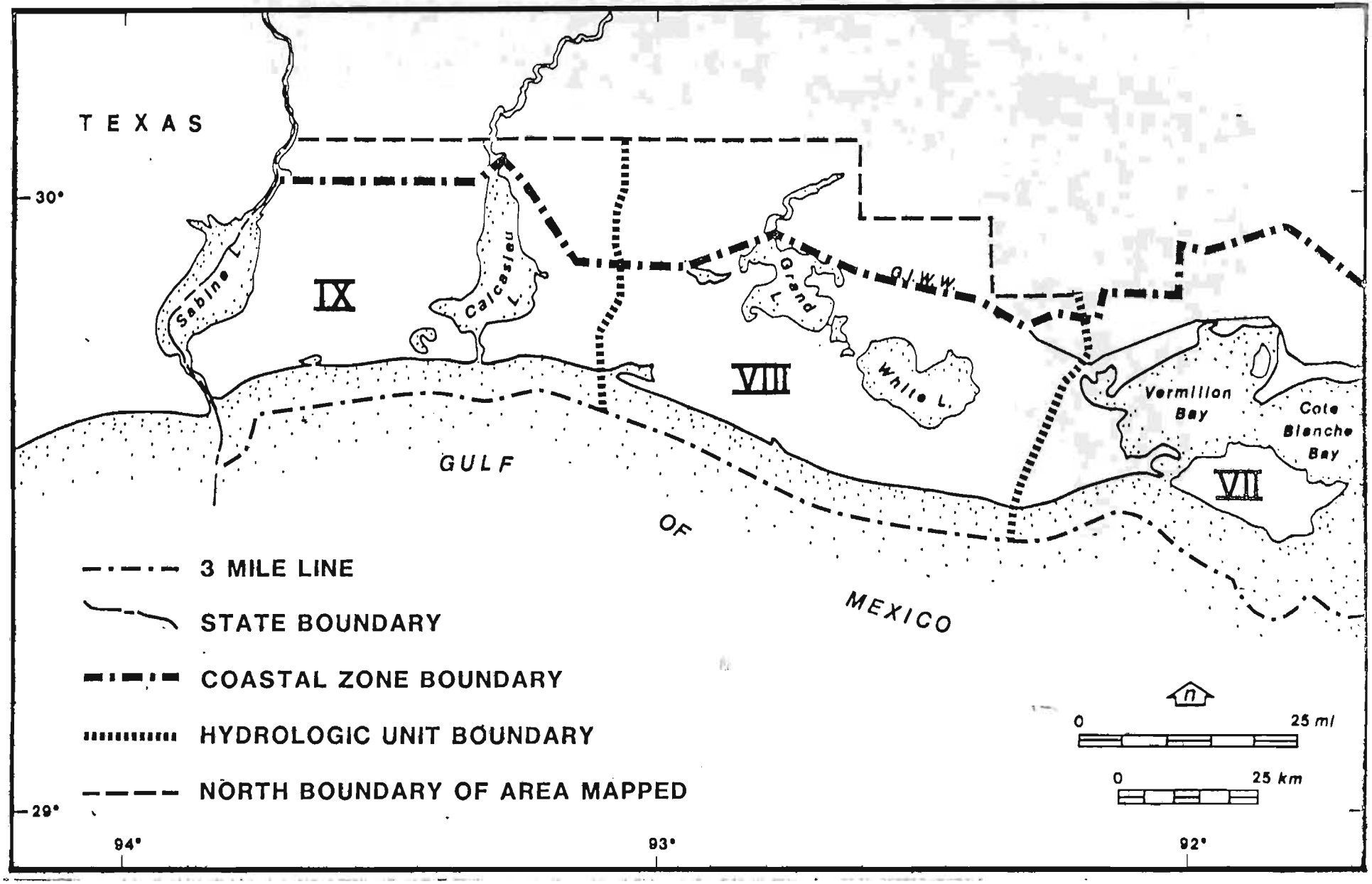


Figure 1. Location of Chenier Plain study area. (Note that as an extension of the Mississippi River Deltaic Plain Region habitat mapping study, the western hydrologic units are labeled VIII and IX.)

currents, and the shoreline prograded through the development of mudflats and coastal marsh deposits. When the Mississippi River shifted eastward, sediment supplies decreased and the gulfward progradation of the Chenier Plain slowed. In some instances, marine processes eroded the shoreline, creating beach ridges. This alternating progradation and erosion of the Chenier Plain was cyclic and resulted in a series of abandoned beach ridges which mark ancient shorelines. The oldest ridges are the Chenier-Little Pecan Island trend, the back ridge of Belle Isle, Junius Ridge, and Wildcat Ridge. These ridges have been radiocarbon dated at 2800 years before present (B.P.) and formed well after sea level reached a still stand about 4600 years B.P. (Gould and Morgan 1962). One of the longest ridges is Grand Chenier which extends eastward from the Mermentau River for almost 70 mi (112 km). Like most ridges, this one is narrow, about 400 yds (36 m), except where prongs curve inland over the marsh, and seldom exceeds 10 ft (3 m) in elevation (Russell and Howe 1935). However, cheniers are very distinctive features, naturally vegetated by live oaks (Quercus virginiana), on the otherwise low-lying, low-relief, coastal marshlands. Because of this prominence, the region is labeled Chenier Plain; Chêne being the French word for oak (Gould and Morgan 1962).

The entire study area was photographed in color infrared (CIR) film by NASA in October 1978. These photographs were used for the interpretation. They are of high resolution and were enlarged to a scale of 1:24,000, but were not quad-centered or controlled. This coverage is the most complete and recent imagery of habitats in the Chenier Plain Region.

The habitat maps were constructed at a scale of 1:24,000 for two primary reasons. First, this is a convenient scale for mapping habitats and generating information useful in coastal habitat and landuse evaluation, planning, and management. Second, the land area within the entire study area had already been mapped by the U.S. Geological Survey (USGS) at this scale in the form of topographic maps, orthophoto maps, or orthophotoquads which were available as base maps (Appendix 3). The entire area was also covered by controlled, quad-centered, black-and-white photo-mosaics dated 1955/1956 and prepared by Tobin Research, Inc..

There are 61 topographic-sized habitat maps covering the study area (Figure 2; Appendix 3). Of this total, 53 maps show land and 8 depict open water. The open water habitat maps were constructed to show the study area out to the three-mile

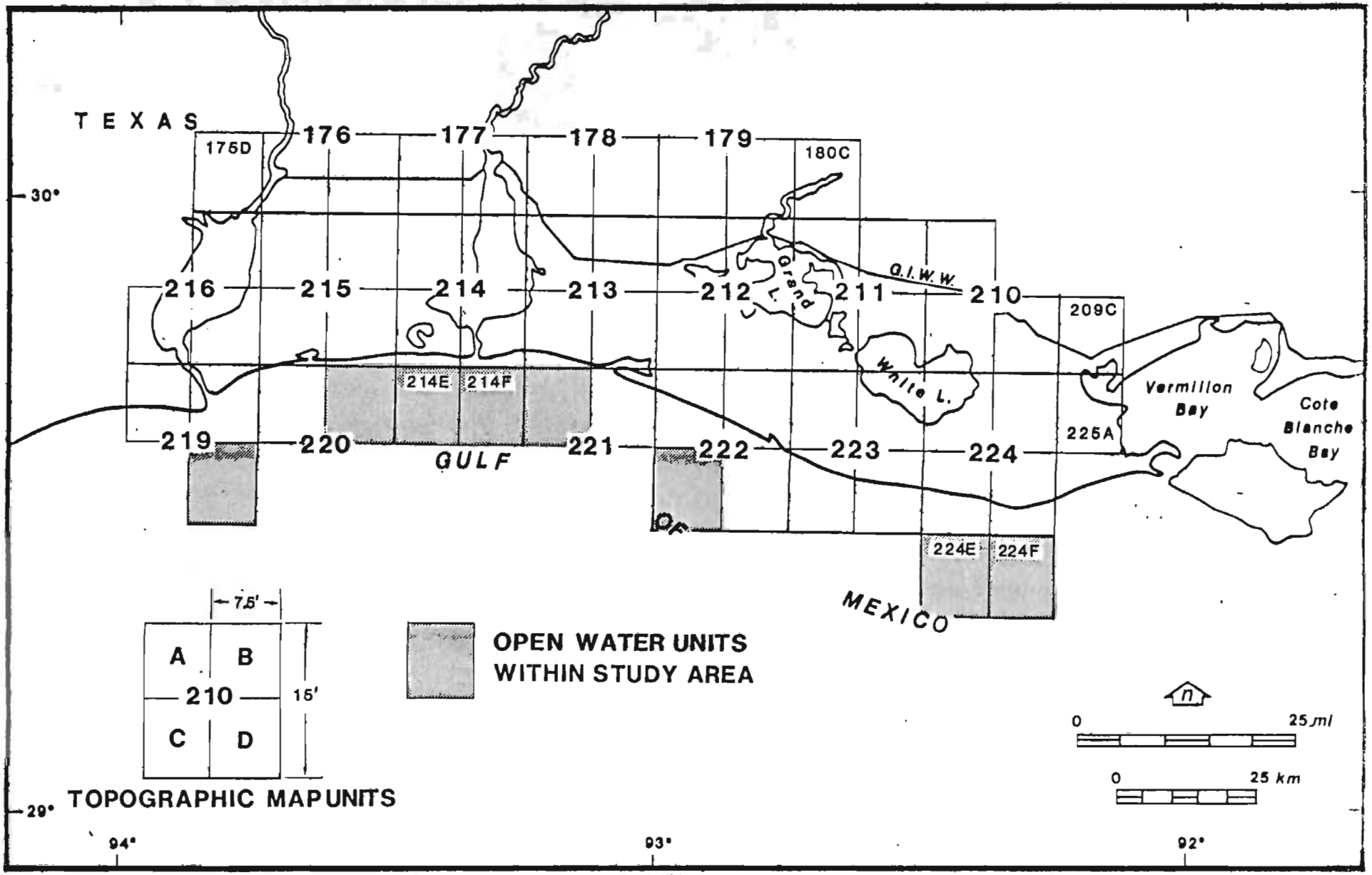


Figure 2. Location of topographic map units interpreted and measured within the study area. (See Appendix 3 for a complete listing of topographic map names and numbers. There are no maps for the shaded areas.)

State-Federal demarcation line. They contain State, parish, and hydrologic unit boundaries where necessary. Wherever the USGS included a small land mass outside the 7.5 minute boundary of their topographic map, a habitat map was constructed for this land mass for the purpose of this study. It was labeled north, east, south, or west of the original USGS topographic map according to the side from which the land mass extended.

For convenience in filing and retrieving the large numbers of maps and photographs used in this project, each 7.5 minute map was assigned a number and letter (Figure 2; Appendix 3). The location of the 7.5 minute maps, their alphanumeric label, hydrologic unit, State, coastal zone, three-mile, and parish boundaries were illustrated on a 1:250,000 master map. With this method, it was easy to discern the boundary data and position of individual areas within the study area and to quickly locate the maps and relevant photographs. Because the 1978 CIR photographs were not quad-centered, individual flight lines for each mission were transposed onto a labeled topographic map grid (Figure 3). The individual photo frames and frame numbers were shown on the grid, making it easy to determine which photographs covered a particular topographic map unit.

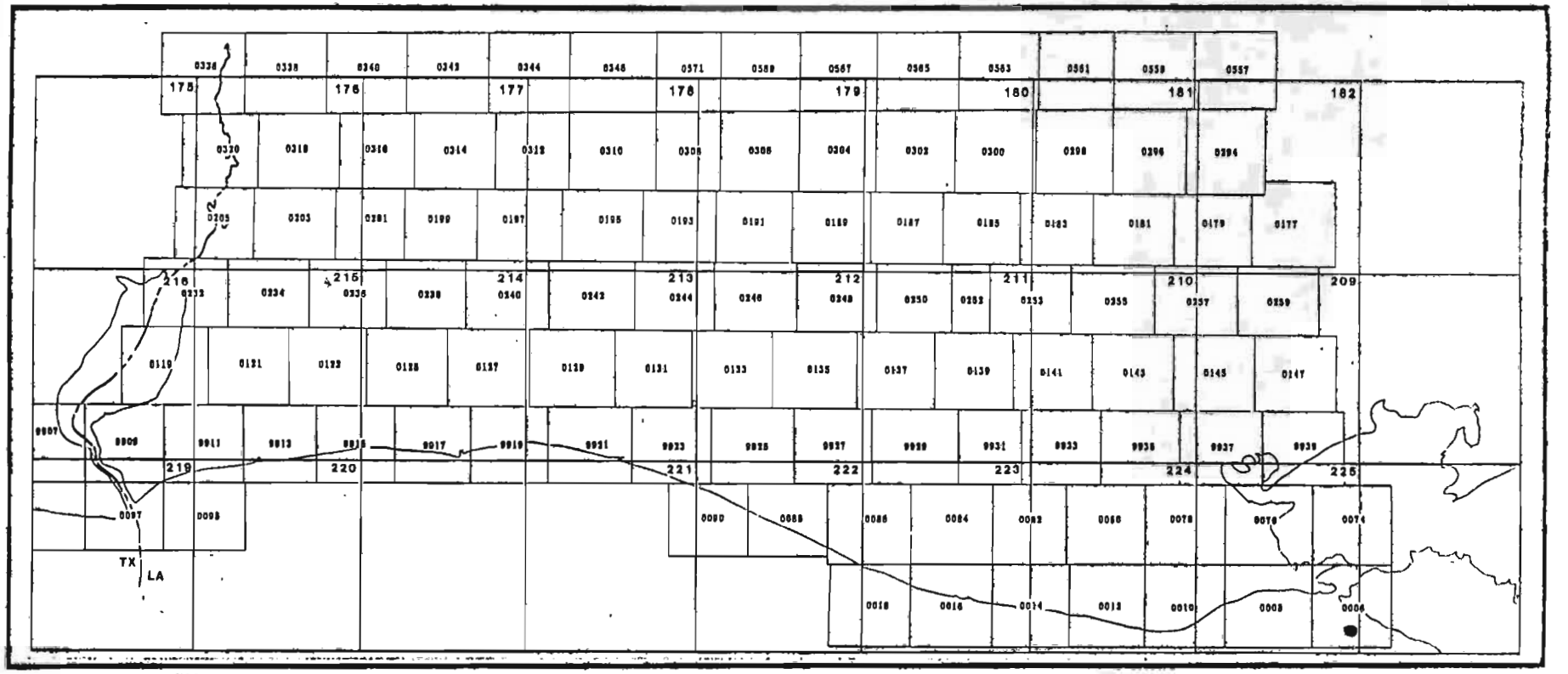


Figure 3. *Locations of 1978 CIR photographs with regard to USGS 15 minute topographic maps. Each large block represents four 7.5 minute maps. The bold-face numbers represent code numbers for the USGS topographic maps. The numbers inside the small blocks are the frame numbers for 1978 imagery (after NASA 1978).*

CHAPTER II: CLASSIFICATION OF HABITAT TYPES

Source and Extent of Classification System

The method for identifying and labeling habitats within the study area was adapted from the FWS Classification of Wetlands and Deep-Water Habitats of the United States (Cowardin et al. 1979) and modified through the National Wetland Inventory of the FWS (n.d.). This classification system is based on a hierarchical structure composed of 1) system and subsystem, 2) class and subclass, and 3) modifiers (water regime, water chemistry, soil, and special) (Appendix 4). Because this particular project included mapping of nonwetland habitat types, the classification system was modified to include a nonwetland, upland system (U) and a developed class (DV) (Appendix 4). Numerical modifiers were added to this class label to indicate urban-industrial-residential (1), agriculture-pasture-grasslands (2), and unvegetated wetlands (i.e., spoil, cleared areas) (3) (Appendix 4).

Other modifiers were added to the existing classification system to more clearly define habitats peculiar to coastal Louisiana. These include reclaimed wetlands under cultivation (e), oil/gas/mineral-related habitats (o), and estuarine tidal channels (t). A complete identification of all habitat labels used in this mapping project is included in the Glossary (Appendix 5).

One advantage of this system of habitat classification is that it permits labeling of a habitat in varying degrees of detail according to the data base available for the major systems within the study area. For example, a nonfresh marsh can be labeled simply as E2EM (Figure 4). If the vegetation is known to be narrow-leaved persistent, such as smooth cordgrass (Spartina alterniflora), add a "5." If the wetland is regularly flooded by tidal processes, this can be shown by attaching an "N." When the salinity is known, a coastal salinity modifier is added. In the case of a saline marsh, "4" signifies a polyhaline regime with salinities ranging from 18 to 30 ppt (Cowardin et al. 1979). Finally, if the natural marsh environment has been altered by ditching and partial draining, this condition can be noted by using a special modifier "d."

Explanation of Habitat Map Symbols:

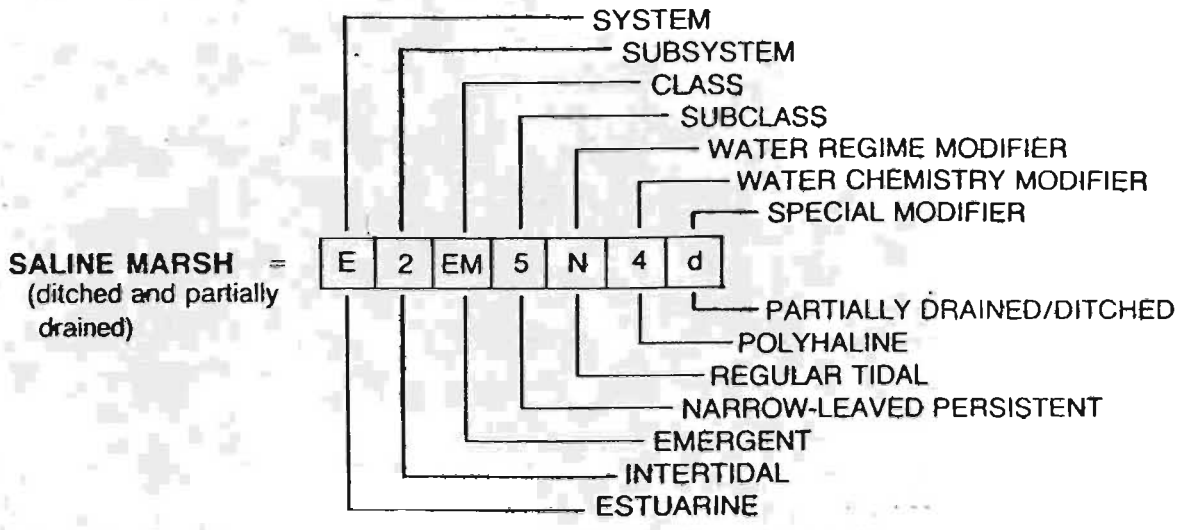


Figure 4. An example of habitat labeling.

Mapping **Constraints**

There are a number of constraints involved in mapping habitats within the Chenier Plain Region. For example, there is a lack of statewide, detailed (to the subclass and water modifier level) habitat information for specific time periods and individual habitats. In general, there are more specific data, such as maps, available on vegetation distribution than on water chemistry and water regimes. Identification of water regimes within streams and canals was particularly difficult within the Chenier Plain Region because of the large number of control structures, such as weirs and pumping stations, and their erratic operating schedule.

This habitat map series is not identical in detail to the USGS topographic maps because its primary purpose is to illustrate the extent of habitats important for fish and wildlife interests. For example, many industrial sites, roads, and housing clusters were interpreted as a single habitat because they function as a nonwildlife habitat and there was no purpose in separating them. Some features, such as narrow canals, could not be discerned on aerial photographs because they were obscured by the vegetation overstory. The USGS topographic maps are not always useful in locating some features, especially canals, because they are of varying dates and are not always

temporally consistent with the CIR photographs. Many of the more recent USGS topographic maps of the Chenier Plain have relatively poor resolution because they are advance prints of orthophotoquads and lack up-to-date cultural interpretations regarding pipeline canals, roads, and other recent cultural habitat changes.

Procedures of Habitat Mapping

Aerial photographs were used as the major basis for habitat interpretation on the 1978 maps. However, other information sources; such as topical maps, topographic maps, published reports, and field reconnaissance; were essential for detailed habitat identification, especially on the subclass and modifier levels. An understanding of the past and present, natural and man-made forms and processes characteristic of the Chenier Plain Region was also essential to habitat identification. In this region, morphology closely governs the vegetation associations which characterize and distinguish individual habitats. An understanding of local hydrologic processes also facilitates aquatic and marine habitat identification even where scientific data are inadequate or absent. Familiarity with landuse practices within the Chenier Plain Region is necessary for identification of habitats that have been modified by man.

In identifying mappable categories on aerial photographs, it is advisable to approach the task in a systematic manner, beginning with what is obvious and capable of being outlined and proceeding to collateral information for details on classification and labeling. Within the Chenier Plain Region, all mappable features fit into one of four major categories: aquatic, vegetated, unvegetated with structures, and unvegetated without structures.

Labeling aquatic habitats requires a knowledge of salinity and tidal influences and water body size, depth, and origin. Much of this kind of information must be acquired from collateral sources, such as topical maps and reports. The identification of vegetated habitats requires a familiarity with plant morphology or species type. Where vegetated habitats occur in wetland areas (e.g., ponds, lakes, embayments, rivers), a knowledge of the water regime is essential.

Nonvegetated habitats exhibiting no structures are classified primarily through geomorphic associations, i.e., the feature's appearance as a beach, flat, reef, or unconsolidated bottom and the material composition available in a particular area,

such as sand, shell, mud, boulders, organic matter, etc. The feature's form would determine its class and its composition would determine its subclass. The classification of these features into system and subsystem requires the identification of water bodies with which they are commonly associated.

Nonvegetated habitats exhibiting structures are easily identified to system, subsystem, and class level because of their obvious man-made appearances. Field reconnaissance and topographic maps were useful in identifying the type of man-made feature, but for the purpose of this study, no modifiers, with the exception of mineral-related activities, were used.

Aerial Photographic Interpretation

Habitat maps can be made from aerial photographs by identifying, categorizing, and outlining the information contained within the photographs. The amount of data that can be obtained from a photograph depends upon the interpreter's ability, familiarity with the landscape shown in the photograph, the scale and resolution of the photograph, and the type of photograph (CIR, black-and-white, color, etc.). Certain keys, or signatures, on photographs can be used alone or in combination to identify the habitats that are to be mapped. Some important keys in air photo interpretation are: color, tone, texture, shape, size, pattern, site (location), association, and shadow (Avery 1969; Ray 1960; Reeves et al. 1974). Examples of habitats located in the Chenier Plain Region and their identifying characteristics are listed in Table 1.

In this particular project, the resolution, or sharpness of the features on the photographs used for interpretation, was very good and the habitats were clearly shown. Because it is possible to discern considerable detail on photographs with high-quality resolution at this large scale (1:24,000), the mapping process had to be selective, and many readily discernible features (e.g., individual houses and roads) were grouped into larger mapping categories. This grouping was done partly because of the restrictions on the time allotted to interpret and draft the final maps, but in most instances mapping in greater detail was not essential to the scope of the project.

Table 1. Characteristics of Habitats that can be Discerned on Aerial Photographs.

HABITAT	EXAMPLES OF SIGNATURES PRESENT ON AERIAL PHOTOGRAPHS					
	COLOR (COLOR INFRARED)	TONE (BLACK-AND-WHITE)	SHAPE	ASSOCIATION/SITE	SIZE	TEXTURE
WATER:						
Ponds/Pits	Dk blue-lt blue	Near black-lt grey	Round, linear rectangular, irregular	Natural, construction, mining, farms	<20 ac	Smooth
Lakes	Dk blue-lt blue	Near black-lt grey	Round, irregular	Natural	>20 ac	Smooth
Impoundments	Dk blue-lt blue	Near black-lt grey	Irregular	Reservoirs, dams	Varies	Smooth
Embayments	Dk blue-lt blue	Near black-lt grey	Irregular	Open water	Varies	Smooth
Gulf	Dk blue-lt blue	Near black-lt grey	Irregular	Open water	Very large	Smooth
Rivers:						
Lower Perennial	Dk blue-lt blue	Near black-lt grey	Linear	Floodplains, natural levees	Varies	Smooth
Tidal	Dk blue-lt blue	Near black-lt grey	Broadens from head to mouth	Coast	Varies	Smooth
Estuarine	Dk blue-lt blue	Near black-lt grey	Broadens from head to mouth	Coast	Varies	Smooth
Canals:						
Pipeline	Dk blue-lt blue	Near black-lt grey	Linear	Spoil, oil industry	≈40 ft wide	Smooth
Rig Cut	Dk blue-lt blue	Near black-lt grey	Linear with rectangular end	Spoil, oil industry	≈70 ft wide	Smooth
Drainage	Dk blue-lt blue	Near black-lt grey	Linear	Spoil, wetlands	≈10-50 ft wide	Smooth
Navigation	Dk blue-lt blue	Near black-lt grey	Linear	Spoil, coast	≈40-500 ft wide	Smooth
Logging	Dk blue-lt blue	Near black-lt grey	Linear, radial	Spoil, swamps	≈20-70 ft wide	Smooth
VEGETATED:						
Trees	Red, purple	Dk grey, mottled	Irregular	Swamps, uplands	>20 ft height	Medium-coarse
Shrubs	Red	Dk grey	Irregular	Coast, disturbed areas	<20 ft height	Fine-medium
Grasses/Herbs:						
Dunes	Pink	Lt grey	Linear	Beach dunes	1 in-4 ft	Fine
Pasture/Agriculture	Red, pink	Dk grey-lt grey	Polygonal, rectangular	Farms	1 in-12 ft	Fine
Emergent	Red, pink, orange, brown	Lt grey, mottled	Irregular	Wetlands, coast	1 in-12 ft	Fine-medium
Flats (pioneer vegetation)	Lt pink-yellowish-orange	Lt grey	Linear-irregular	Deteriorating wetlands, stillwater	Variable	Medium
Floating Aquatics	Red, pink, lt brown	Medium grey	Linear-irregular	Freshwater bodies	.5 in-4 ft	Fine-medium
Floating-Leaved Aquatics	Pink	Medium grey	Round mat-fan	Freshwater bodies	.5 in-1 ft	Fine-medium
Submerged Vascular	Lt pink, cream, white	Lt grey	Irregular	Shallow water	1 ft-6 ft	Fine
Submerged Algal	Lt pink, cream, white	Lt grey	Irregular	Shallow water	<1 in	Fine
Cleared Rights-of-Way	Reddish-brownish (vegetation growth checked)	Lt-medium grey	Linear	Roads, utilities, pipelines	≈50 ft wide	Fine
UNVEGETATED (without structures):						
Bare Material (Spoil)	White	Lt grey-white	Polygonal, linear, irregular	Oil industry, mining, construction	Variable	Smooth-fine
Beach	White	White	Linear	Wave action, open water, shoreline	Variable	Smooth-Fine
Flat:						
Sand/Shell	White	White	Linear, patchy	Wave-worked shoreline	Variable	Smooth-fine
Mud/Organic	Grey-grey/green	Lt grey	Linear, patchy	Protected shoreline	Variable	Smooth-fine
Unconsolidated Bottom:						
Sand	Lt blue	Lt grey	Irregular	Water bottoms	Variable	Rippled
Mud/Organic	Lt grey-green	Lt grey	Irregular-linear	Intertidal flats	Variable	Fine-medium
Reef	White	White	Linear	Oyster grounds	Variable	Medium
UNVEGETATED (with structures):						
Urban Industrial	White	Lt grey-white	Polygonal, rectangular	Development	Variable	Smooth-medium
Roads	White	White	Linear	Development	≈50-300 ft wide	Smooth
Protection Levees	White, red (if covered with grass)	Lt grey-white	Linear	Flooding rivers, hurricane surge zone	≈10-335 ft wide	Smooth-fine
Jetty	Grey	Medium grey	Linear	Shoreline	≈20 ft wide	Medium

Aquatic Habitats

Identification on Aerial Photographs

Water bodies are easily recognized on CIR imagery by their blue to blue-green color and smooth texture. Color also indicates turbidity, with dark blue indicating clear water and turbid water being lighter blue-green to coffee colored. The shade or tone on black-and-white imagery also varies from very dark to very light, darkest when the water is clear and lightest when it is very turbid. The series of 1955/56 black-and-white photographs (Tobin Research, Inc. 1955/56) for the Chenier Plain Region was used for comparative purposes with the 1978 CIR photos even though they were not interpreted in this study.

The type of water body (i.e., pond, borrow pit, lake, embayment, river, canal) is distinguishable primarily by shape and size, and secondarily by association (location) and pattern. In the FWS classification system (Cowardin et al. 1979), freshwater systems are called ponds if they are less than 20 ac (8 ha) in area, and lakes if they are more than 20 ac (8 ha) in area. Nonfresh water bodies are not distinguished by size or depth. Rivers are natural drainage systems that extend from inland regions to the coast and possess various drainage patterns, i.e., dendritic, radial, meandering, or anastomosing (Figure 5). Rivers are classified as intermittent, tidal, or nontidal (lower perennial) when fresh. When nonfresh, all drainage patterns are classified as tidally influenced estuarine. Embayments are considerably larger than lakes, are estuarine, and usually open directly into the Gulf of Mexico. In coastal Louisiana, embayments often consist of eroded interdistributary lakes and interconnected tidal channels. Within the Chenier Plain Region there are four extremely large lakes (Sabine, Calcasieu, Grand, and White) in the interior marshlands that have become progressively more saline due to saltwater intrusion along the Gulf Intracoastal Waterway (GIWW) and other canals and channels stretching from the Gulf inland. These are unlike the embayments in the Deltaic Plain because they are enclosed by marshes and have narrow openings to the Gulf of Mexico. Sabine and Calcasieu Lakes are connected to the Gulf via narrow, deep, navigation channels, while Grand and White Lakes are connected to each other and to Vermilion Bay by the Old Intracoastal Waterway. The Mermentau River also connects Grand Lake with the Gulf. The Gulf of Mexico is located seaward of the Chenier Plain coast. The Gulf within the three-mile limit can be labeled variously as estuarine or marine, depending upon the salinity

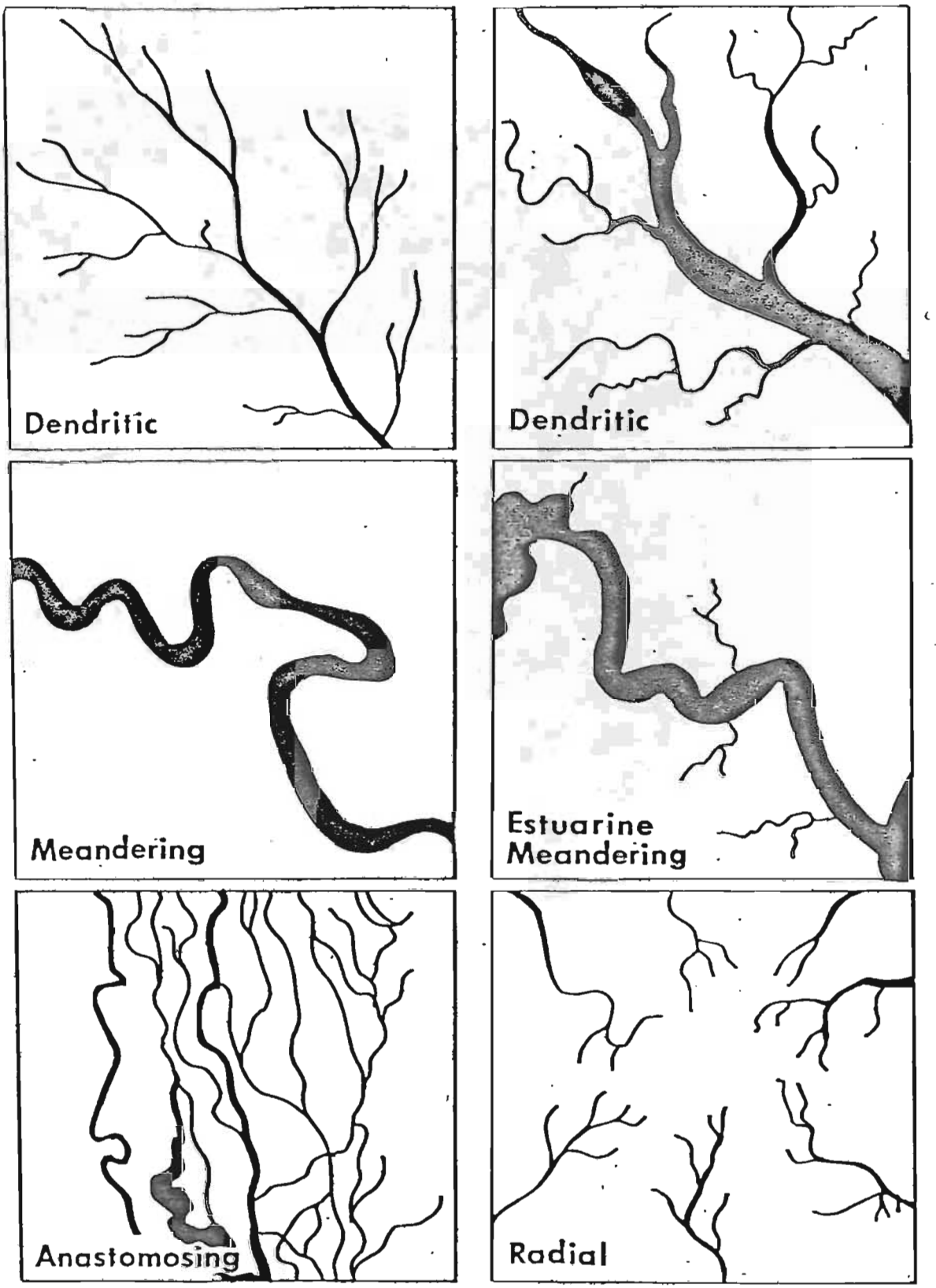


Figure 5. Examples of drainage patterns present in coastal Louisiana.

as influenced by major rivers, such as the Mississippi and Atchafalaya, but for the purpose of this study it is considered to be estuarine.

Canals are easily distinguished from natural drainage channels by their straight, parallel banks and regular, repetitive patterns (Figure 6). Logging canals are the narrowest and are located in swamps or at the site of previous logging activities. The canal pattern varies according to the type of logging activity. Logging scars are rarely mapped in the Chenier Plain Region because swamps are very restricted in area, being largely confined to narrow, riverine floodplains and south of the Prairie Terrace in the northeastern portion of Hydrologic Unit VIII. Rig cuts are identified by their approximately 150 ft (46 m) wide, rectangular water body, often containing drilling equipment, at the end of a canal which is approximately 70 ft (21 m) wide when first dredged (Davis 1972). A rig cut may be a single, short canal off a natural channel or one of many interconnecting canals (Figure 6). Pipelines, whether for oil or gas, are narrower than rig cuts, about 40 ft (12 m) wide when dredged (Barrett 1970). They run in straight lines from a few miles to hundreds of miles, and when they change direction they possess a curved rather than right-angled bend (Figure 6). Many pipeline canals in the Chenier Plain Region are difficult to map from CIR photos because they are discontinuous and indistinct, often masked by marsh vegetation. Another common canal type in coastal Louisiana is the borrow pit situated adjacent to a protection levee or road embankment. Often these canals are as wide as the associated levee and embankment (Figure 6).

Classification of Habitat Type

Water bodies are the easiest features to locate on air photos but are among the most difficult to classify with the FWS system. Water bodies can fall under any one of five systems (marine [M], estuarine [E], palustrine [P], riverine [R], and lacustrine [L]) depending upon their salinity, size, and shape (Figure 7; Table 2). The subsystem classifications are determined by tidal influence, flow duration, and/or depth.

All marine and estuarine water bodies fall within the subtidal system. Palustrine water bodies are not distinguished as to subsystem but must be less than 20 ac (8 ha) in area. Lacustrine water bodies are greater than 20 ac (8 ha) and are divided into two subsystems: limnetic if they are over 6 ft (1.8 m) deep and littoral if they are under 6 ft (1.8 m) deep. The three riverine subsystems within the Chenier Plain Region are tidal, lower perennial (nontidal), and intermittent.

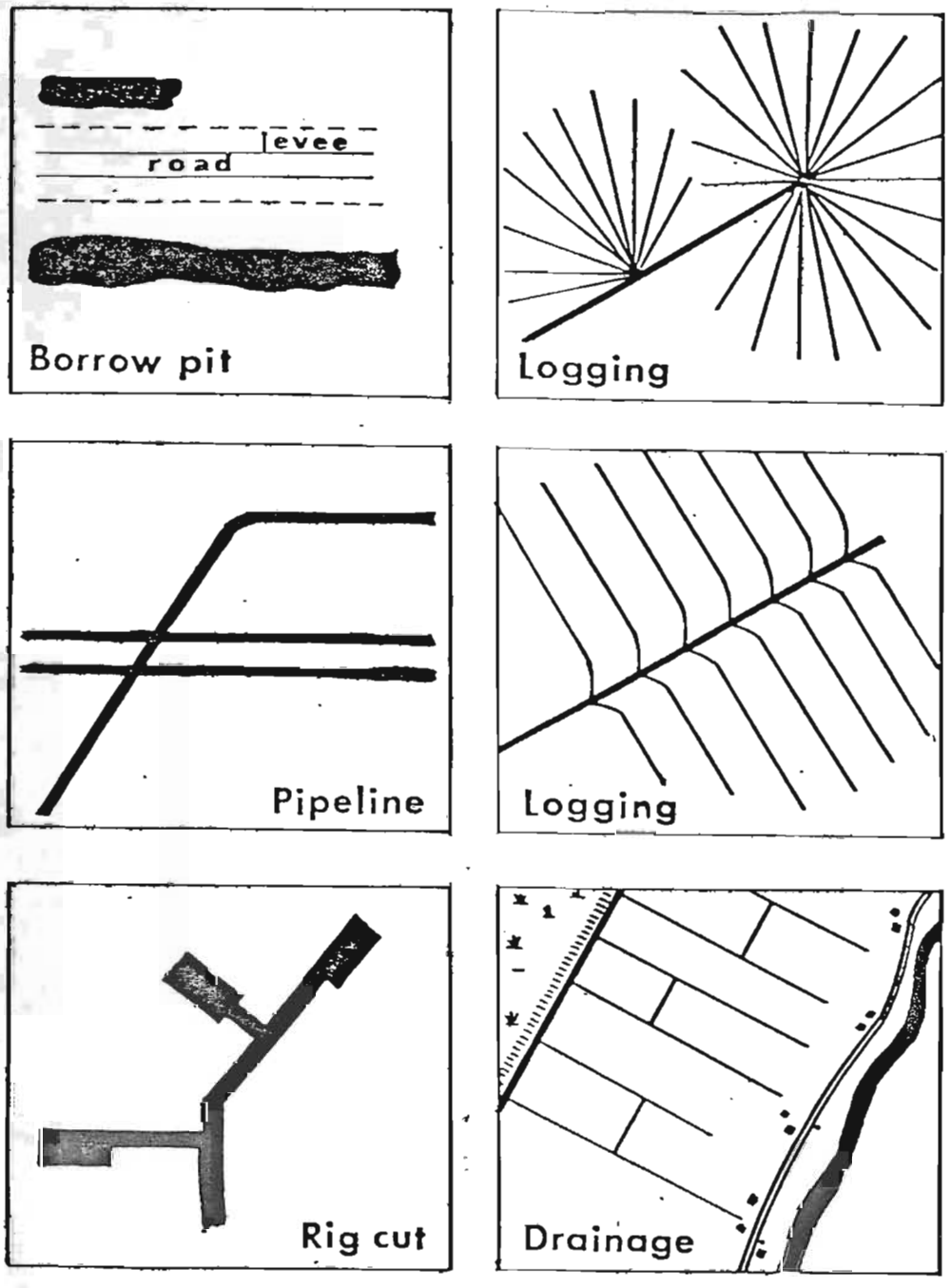


Figure 6. Characteristic shapes of canals common in coastal Louisiana.

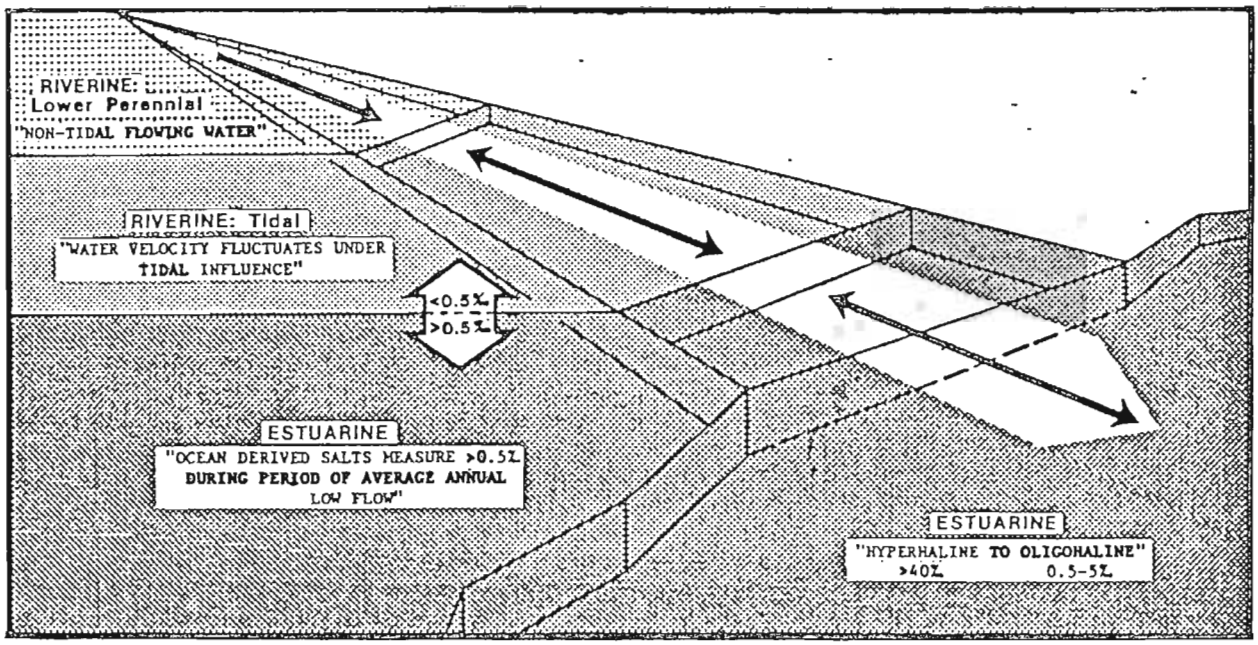


Figure 7. Schematic diagram illustrating differences among riverine, riverine tidal, and estuarine reaches of a channel.

Table 2. Size, Shape, and Salinity Characteristics of Aquatic Systems.

SYSTEM	SALINITY	SIZE	SHAPE
Marine	> 30 ppt	NA*	Open Gulf
Estuarine	> 0.5 ppt** to 30 ppt	NA	Irregular/Channelized
Palustrine	< 0.5 ppt	< 20 ac (8 ha)	Irregular
Lacustrine	< 0.5 ppt	> 20 ac (8 ha)	Irregular
Riverine	< 0.5 ppt	NA	Channelized

* Not applicable.

** During the period of average annual low flow.

Source: Cowardin et al. 1979.

In the Chenier Plain Region, salinity is highly variable daily, seasonally, yearly, and throughout the water column because of climatic factors and variations in discharge from major rivers such as the Atchafalaya, Vermilion, Mermentau, Calcasieu, and Sabine. Weirs, locks, and floodgates are also used to control water salinities on a seasonal basis in some areas of the Chenier Plain. Isohaline maps of the region often show large variations in the surface or mid-depth salinity values for individual months (Chabreck 1972; Gagliano et al. 1970a; Murray 1976) (Figure 8). Thirteen stations within the Chenier Plain Region, maintained by the U.S. Army Corps of Engineers (USACE) (1963), also show large variations in mid-depth mean values between 1947 and 1961 (Table 3). While these data were evaluated for the purpose of classifying aquatic systems, the most useful data were derived from a recently published marsh vegetation map (Chabreck and Linscombe 1978). This map could be used to distinguish between estuarine and nonestuarine, either tidal or lower perennial, water bodies, because marsh types develop in response to salinity regimes (Chabreck 1962; Palmisano 1970; Penfound and Hathaway 1938). Therefore, all water bodies located within intermediate, brackish, or saline marshes were labeled estuarine because they experience salinities greater than 0.5 ppt during periods of low flow. Those water

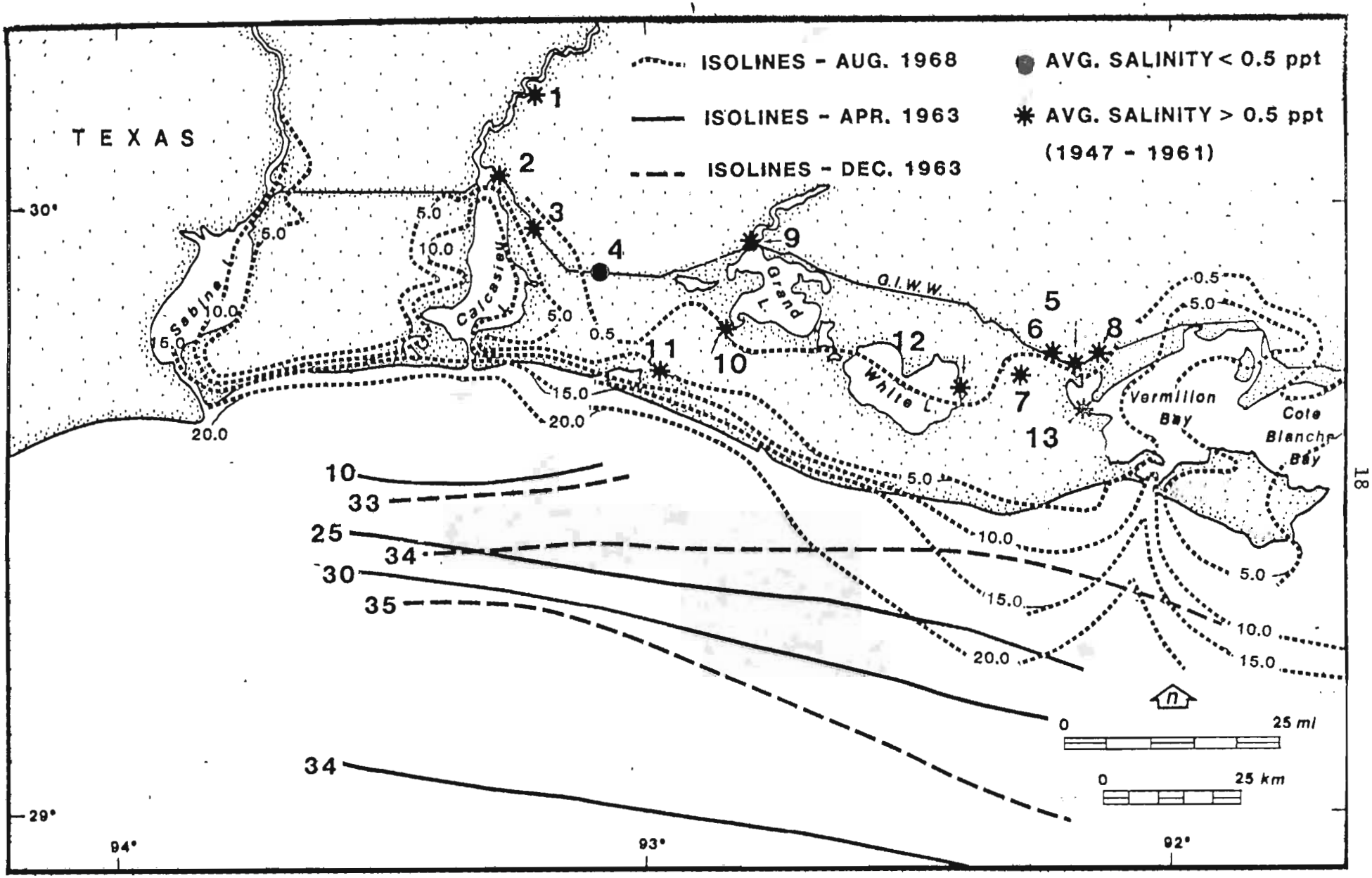


Figure 8. Salinity data for the Chenier Plain Region (after Chabreck 1972, Gagliano et al. 1970b, Murray 1976, USACE 1963).

Table 3. Recorded Salinity Values within the Chenier Plain Region between 1947 and 1961.

STATION NO.	STATION NAME AND LOCATION	MID-DEPTH CHLORINITIES: MEAN VALUE FOR THE YEAR															AC[1]	AS[2]
		1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961		
	Calcasieu River																	
1	Near Lake Charles, LA	---	---	---	---	---	6.05	4.74	8.41	4.16	5.96	1.86	1.88	2.61	2.95	1.21	3.98	7.19*
	Gulf Intracoastal Waterway, Mile 240-155																	
2	Calcasieu Lock (East)	---	---	---	---	5.72	2.50	2.39	6.35	1.37	5.80	0.88	1.38	1.68	2.73	0.93	2.88	5.20*
3	LA 384	6.29	4.44	1.30	2.04	3.32	---	---	---	---	---	---	---	---	---	---	3.48	6.28*
4	LA 27 (Gibbstown Bridge)	---	---	---	---	---	---	---	---	---	---	---	---	0.13	0.45	0.23	0.27	0.49
5	Vermilion Lock (East)	---	---	---	---	---	---	0.54	1.42	---	---	---	---	---	---	---	0.98	1.77*
6	Vermilion Lock (West)	---	---	---	---	---	---	0.35	2.48	0.29	1.91	0.22	0.25	0.27	0.63	0.26	0.74	1.33*
7	Schooner Bayou Control Structure (West)	1.64	1.64	1.27	0.86	1.28	1.35	0.44	1.86	0.30	1.09	0.52	0.25	0.35	0.55	0.33	0.92	1.67*
8	At Vermilion River	---	1.97	0.27	0.37	0.99	1.45	0.45	1.09	---	---	---	---	---	---	---	0.94	1.70*
	Mermentau River																	
9	At Lacassine Refuge, LA	2.07	2.08	0.09	0.54	0.34	0.06	0.04	0.29	0.04	0.11	0.03	0.04	---	---	---	0.48	0.86*
10	Catfish Point Control Structure	---	---	1.07	1.21	1.89	0.30	0.21	2.00	0.17	1.51	0.39	0.31	0.37	2.05	0.34	0.91	1.65*
11	At Grand Chenlere, LA	9.58	7.63	2.87	3.91	5.52	4.51	4.43	---	---	---	---	---	---	---	---	5.49	9.92*
	White Lake																	
12	Old Inland Waterway	---	2.03	1.24	0.76	1.06	0.57	0.20	0.25	---	---	---	---	---	0.86	0.29	0.81	1.47*
	Vermilion Bay																	
13	At Little Bay	---	2.94	0.45	0.47	1.47	2.54	0.96	2.44	---	---	---	---	---	---	---	1.61	2.91*

[1]Average chlorinity.

[2]Average salinity.

*Stations considered to be estuarine for habitat mapping purposes on the 1955 map series.

Source: Gagliano et al. 1970b.

bodies in freshwater swamps and marshes were considered fresh (palustrine and lacustrine) or riverine (tidal or lower perennial) unless specific information indicated otherwise. Some channels penetrating into freshwater wetland areas were labeled estuarine if they were large or channelized and connected to water bodies that were estuarine according to the plotted salinity readings. This method of labeling relied heavily on extrapolation from known salinity readings and an understanding of water movement, especially the location of weirs and locks and the presence of saltwater wedges and mixing during periods of low precipitation and runoff within the coastal wetlands. In some instances, Chabreck (1981, personal communication) provided information on the subsystem classification of water bodies.

The nearshore Gulf area within the three-mile State-Federal demarcation line was labeled estuarine. The break between estuarine and marine habitats is the 30 ppt isohaline (Cowardin et al. 1979), and during large portions of the year, salinities in this region are often well below 30 ppt. Further studies and a more stringent distinction between estuarine and marine habitats are needed before these habitat types can be clearly delineated in the nearshore Gulf Chenier Plain Region.

The boundary between tidal and lower perennial water bodies is ill-defined in the Chenier Plain Region because of the lack of data on tidal influence and because of man's influence on water circulation through the installation and/or maintenance of weirs, floodgates, and navigation locks. For the purpose of this study, it was assumed that all channels within the marsh not cut off from normal circulation by dams and artificial levees were subject to tidal influence (either astronomical or meteorological) because of the low-lying, undifferentiated nature of the wetland topography. Channels originating within swamps that were less than 5 ft in elevation were also designated as being tidally influenced because it was assumed that water levels in these normally sluggish bayous would rise and fall under the influence of tides rather than be unidirectional in response to drainage basin discharge. Channels that extended into upland areas, such as natural levees and terraces above the 5-ft contour, were determined to be lower perennial where flow was continuous, and intermittent where flow ceased during some periods of the year.

The FWS (n.d.) distinguishes between all natural and man-made water bodies by affixing an "x," meaning excavated, to man-made water bodies such as canals, borrow pits, and farm ponds. On the Chenier Plain and Mississippi River Deltaic Plain Region

habitat maps, an additional modifier, "o," has been added to distinguish oil and gas canals and pits. Estuarine tidal channels are also modified by the letter "t" to distinguish these channels from other estuarine water bodies such as ponds, lakes, and embayments. A fourth water body modifier "h" stands for diked/impounded. It is attached to both fresh and estuarine water bodies that are created by man, such as reservoirs and impoundments. Abandoned reclamation sites or neglected marsh management areas that are diked, flooded, and contain large expanses of open water are also labeled "h" to distinguish them from natural open water bodies.

Because of the enormous number of canals and natural channels in rice fields, only the longer, wider canals were drawn on the habitat maps. They were labeled riverine, nontidal, unless they were shown as intermittent on the USGS topographic maps. In marshland areas, short, narrow, discontinuous, or indistinct canals, such as trainasses (trapping canals), and pipeline canals, such as the push-end type that were masked by vegetation, were not delineated.

Summary of Habitat Types and Identifying Characteristics

There are 20 water-related habitats identified in the Chenier Plain Region. These habitats were classified through a systematic process beginning with their appearance on air photos and proceeding to a measurement of their size, an analysis of their shape, and consultation with collateral sources to determine salinity, water regime, depth, and origin or function. The defining characteristics of these aquatic habitats are illustrated in Table 4.

In general, delineating salinity and tidal regimes in the Chenier Plain Region was more difficult than in the Mississippi River Deltaic Plain Region because of the large expanses of low-lying marsh that have been reclaimed for rice and pasture or diked for marsh management for furbearers and waterfowl. Therefore, in areas of agriculture and improved pasture, all interior channels were labeled lower perennial and nontidal because, in virtually all cases, water levels are controlled with weirs and/or pumps. Within leveed marshlands, interior water bodies were labeled estuarine if the marshlands were nonfresh, and fresh (lacustrine, palustrine, or riverine) if the marshlands were known to be freshwater marsh habitat. If the levees were substantial and in good repair, and weirs or dams were visible on the photographs or topographic maps, the interior channels were labeled nontidal. Channels in leveed marshlands that appeared

Table 4. Water-Related Habitats and their Defining Characteristics.

SYMBOL	DEFINITION/NAME	SIZE/ DEPTH				SHAPE		SALINITY		WATER REGIME			ORIGIN			
		<20 AC	>20 AC	>6 FT	<6 FT	LINEAR	NONLINEAR	FRESH	ESTUARINE	TIDAL	LOWER PERENNIAL	INTERMITTENT	EXCAVATED	OIL/GAS	IMPOUNDED	NATURAL
POW	Pond	X				X	X	X								X
POWx	Pond, pit	X				X	X	X					X			
POWh	Impoundment	X				X	X	X							X	
POWo	Pond	X				X	X	X						X		
L2OW	Lake		X		X		X	X								X
L2OWx	Lake		X		X		X	X					X			
L2OWh	Lake		X		X		X	X							X	
L2OWo	Lake		X		X		X	X						X		
R1OW	River					X		X		X						X
R1OWx	Canal					X		X		X			X			
R1OWo	Canal					X		X		X				X		
R2OW	River					X		X			X					X
R2OWx	Canal					X		X			X		X			
R2OWo	Canal					X		X			X			X		
R4OWx	Intermittent canal					X		X				X	X			
E1OW	Embayment						X		X							X
E1OWo	Canal, rig cut					X			X					X		
E1OWx	Canal					X			X				X			
E1OWh	Impoundment						X		X						X	
E1OWt	Tidal channel					X			X							X

to be less well-managed and with connections to outside tidal channels were labeled tidal. The large interior lakes were labeled estuarine because of saltwater intrusion during low flow (Chabreck 1980, personal communication). The Gulf of Mexico was labeled estuarine because it was difficult to distinguish the boundary between estuarine and marine within the three-mile boundary.

Vegetated Habitats

Identification on Aerial Photographs

Unlike aquatic and unvegetated habitats, both with and without structures, vegetated habitats display a wide variation in color, shape, texture, and location, and it usually requires field reconnaissance and collateral data to verify their photographic signatures and subsequent interpretation (Table 1).

Photographic signatures for vegetation vary because of differences in vegetation type, age, vigor, season, man-made influences, quality of photographs, and variations in photographic processing. On CIR photographs, green vegetation appears in various shades of red and purple, ranging from light pink through bright red to deep maroon and purple. Light green vegetation, such as smooth cordgrass and duckweed (Lemna spp.), appears pinkish, while darker green vegetation, such as live oak, pine (Pinus spp.), and mangroves (Avicennia germinans), is dark red. Water hyacinths (Eichhornia crassipes) have a bright red appearance and cypress (Taxodium distichum) are pinkish purple. Dead vegetation appears in various shades of brown, yellow, and orange on CIR photography. Usually light-colored, dead material such as dry marsh grass is light brown to yellowish orange. Dead aquatics and algal mats are light brown to almost white. In mixed stands of vegetation, the color signature consists of a mottled pattern of various shades of pinks, reds, and purples. Color, however, should not be used as the sole criterion in distinguishing among vegetation species; there is a great deal of variation in color that can be attributed to differences in film and processing quality, atmospheric and ground conditions at the time of the filming, and condition of the vegetation at time of filming.

In addition to color, texture is useful in identifying vegetation because it varies among vegetation types, depending upon the plant's shape, color/tone, vigor, age, and the season of year (Figure 9; Table 1). Where species composition is sparse and the

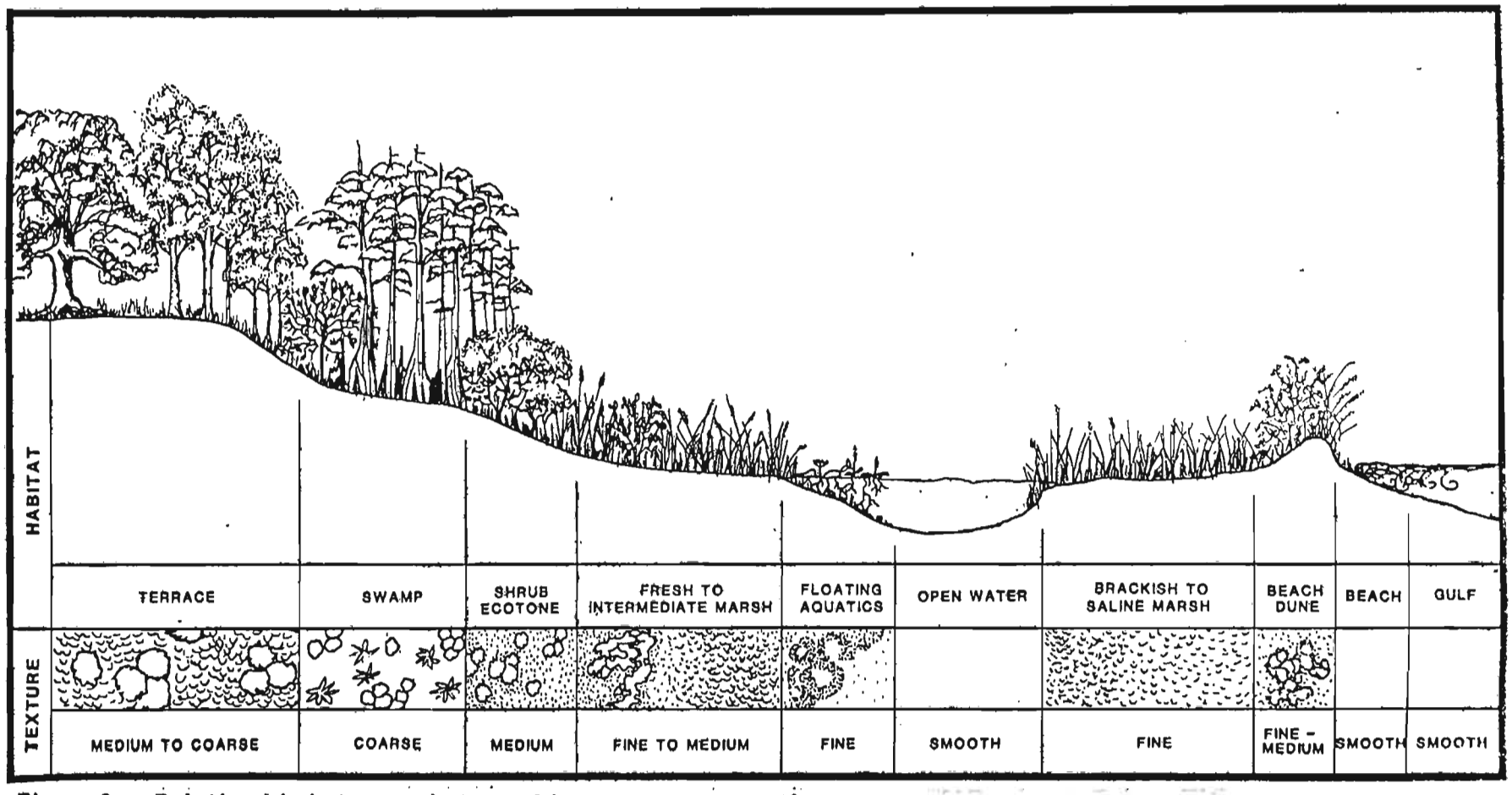


Figure 9. Relationship between photographic texture and specific vegetation associations in the Chenier Plain Region.

photographic scale large with good resolution, individual plant shapes help to identify vegetation communities. With denser stands, smaller scales, and/or lower resolution, the individual plant shapes within the community acquire a distinguishing texture. Homogeneous stands of vegetation (e.g., duckweed and water hyacinth mats, young willows [Salix nigra], and agricultural crops and pasture) have a fine texture. Dense stands of mixed vegetation, such as mixed levee and terrace hardwoods and healthy cypress-tupelogum (Nyssa sylvatica) swamps, are generally medium-textured. This texture is caused by variations in tree height, density, and crown shape, as well as differences in vegetation color or tone. For example, mature live oaks have very conspicuous round crowns while cypress have irregular, somewhat star-shaped crowns, and the crowns of pines are star-shaped (Avery 1969). The coarsest texture is associated with less dense vegetation stands such as overly mature, deep-water willow swamps and stressed, deep-water willow-cypress-tupelogum swamps. Vegetation density is sparse under these conditions and spaces between the trees often appear light in tone and smooth in texture because of light reflecting from either dense aquatic mats or shallow, standing water.

In general, the shorter, more homogeneous stands of vegetation have a fine texture, while the taller, more mixed stands have a medium-to-coarse texture. Stands of shrubs have a texture intermediate between fine and medium depending upon their height and homogeneity. Shrubs are under 20 ft (6 m) in height, while trees are over 20 ft (6 m). While this distinction can be made easily with stereoscopic analysis, the habitat maps were constructed through monoscopic analysis of large-size (19.25- by 19.50-in [48.1- by 48.7-cm]) prints. Therefore, variations in plant height were discerned largely from the shadows cast by the vegetation, field reconnaissance, a knowledge of where shrubs are most likely to occur (i.e., newly accreted lands and spoil banks), and corroboration of USGS topographic and topical maps.

Location (i.e., association with a distinct landform) within the Chenier Plain Region is also helpful in identifying vegetation types. For example, deep-water backswamps usually contain the cypress-tupelo association, while higher, well-drained levees support a mixed hardwood association. The ecotone region between the swamp and levee forest contains bottomland hardwoods that can be separated into two wetland categories: a long hydroperiod and a short hydroperiod. Natural vegetation on the Prairie Terrace always consists of native grasslands or a pine-hardwood association. Beach dunes support salt-spray-tolerant grasses, herbs, and shrubs, while the

abandoned beach ridges (cheniers) are noted for their live oak association. The lowest lying wetlands contain marsh associations whose vegetation is determined by the salinity regime of the flooding waters. Vegetation growing in permanently standing water bodies will consist of floating, floating-leaved, or submerged aquatics. Spoil banks are invariably vegetated by willows and other mixed hardwoods in freshwater areas and by marshelder (Iva frutescens)-eastern baccharis (Baccharis halimifolia)-wax myrtle (Myrica cerifera) associations in more saline areas. Mudflats that are in transition from bare flat to marsh will have pioneer vegetation.

Classification of Habitat Type

Four major categories of vegetated habitats (of 54 individual habitat types) were mapped in the Chenier Plain Region: trees, shrubs, grasses and/or herbs (marsh, dune, agriculture/pasture, pioneer, right-of-way), and aquatic beds (floating, floating-leaved, submerged) (Table 5). Utilization of the FWS Habitat Classification system requires a knowledge of the following vegetation association characteristics:

1) species morphology (i.e., tree, shrub, grass, etc.),
2) species composition (i.e., broad-leaved deciduous, broad-leaved evergreen, needle-leaved evergreen, etc.),
3) elevation of vegetation substrate with regard to water levels and hydroperiod (i.e., backswamp, marsh, intertidal flat, etc.), and
4) soil and water salinity (i.e., fresh, intermediate, brackish, saline).

This mapping of vegetated habitats has the largest number of habitat types because vegetated habitats occur in all six systems of the classification scheme and eight of the thirteen classes (Appendix 4). Identification and classification of vegetated habitats can only be done accurately from aerial photography when collateral information, such as field checking or existing vegetation maps and reports, is utilized. Within the Chenier Plain Region, there is a close correlation between vegetation associations that can be seen on aerial photographs in terms of class and subclass and topographic features (physiographic regions and units) that can be viewed in terms of system and subsystem.

Physiographic maps covering the Chenier Plain Region have been prepared by numerous authors including Byrne et al. 1959, Frazier and Osanik (1969), Gagliano and van Beek (1970), and Gosselink et al. (1979). Among the regional vegetation maps are those of Brown (1945); Chabreck (1972); Chabreck and Linscombe (1978); Chabreck et

Table 5. Grouping of Vegetated Habitats According to Steps (1-4) in Interpretation. Step 1 is Determined by Vegetation Shape, Size, and Texture on CIR. Steps 2-4 are Determined by Vegetation Location and Collateral Information.

1 FORM	2 UPLAND	2 WETLAND			
		3 FRESH			3 NONFRESH
	4 UPLAND	4 PALUSTRINE	4 LACUSTRINE*	4 RIVERINE*	4 ESTUARINE*
SCRUB-SHRUBS	USS1 USS1s USS1/3 USS1/3s USS1/3/4	PSS1 PSS1/2 PSS1/3			
TREES	UFO1s UFO1/3 UFO1/3/4 UFO3	PFO1/2 PFO1/3 PFO1/2/3			
GRASSES-HERBS-FERNS	UDV UDV2 UDV2e UGRp	PEM PEMd PEMm PDV PFL5	L2FL5		E2EM5P5 E2EM5P5d E2EM5P5m E2EM5P5w E2EM5P6 E2EM5P6d E2EM5P6m E2EM5P6w E2EM5N4 E2EM5N4d E2EM5N4s E2FL5
AQUATIC BEDS		PAB5 PAB5h	L2AB L2AB5 L2AB5h	R1AB5 R1AB5x R1AB5o R2AB5o	E1AB E1AB2 E1AB5 E1AB5x E1AB5o E1AB5h

* Step 4, Lacustrine, can have a Step 5: L1 =>6 ft deep.
L2 =<6 ft deep.

Step 4, Riverine, can have a Step 5: R1 = Tidal.
R2 = Lower Perennial.
R4 = Intermittent.

Step 4, Estuarine, can have a Step 5: E1 = Subtidal.
E2 = Intertidal.

* interpreted on 1976 maps only.

al. (1968); O'Neil (1949); U.S. Department of Agriculture (USDA), Forest Service (FS) (1969); and Winters and Ward (1934). Comparison of a map of major physiographic regions and units (Figure 10) with one of major vegetation associations (Figure 11) illustrates the relationship existing between vegetation and landform (Table 6).

The Chenier Plain Region consists of a smaller, northern area of older, elevated Pleistocene deposits on the Prairie Terrace and a larger, southern area within the Chenier Plain proper composed of Recent fine-grained sediments and peat. Virtually all habitats on the Prairie Terrace fall within the upland system. It should be noted that where there are floodplains along streams on the Prairie Terrace above the 5-ft contour, these habitats are considered to be palustrine because of poor drainage. These areas can include any or all of the four major forest subclasses (FO1, 2, 3, 4; Appendix 5), and only field checking can accurately verify identification of these forests from aerial photography.

Historically, the Prairie Terrace consisted of prairie grasslands and scattered stands of pine and mixed hardwoods largely confined to poorly drained depressions along streams and on ridges (Brown 1945) (Appendix 6). At present, nearly all of the natural vegetation has been cleared and replaced by agricultural crops, primarily rice and soybeans rotated with fallow fields utilized as pasture for cattle. In some areas, stands of pine have been planted for wind breaks or timber.

The Recent sediments within the Chenier Plain can be divided into six natural, land-based physiographic units, each having characteristic vegetation associations: natural levee, backswamp, marsh, beach dune, mudflat, and chenier. A seventh unit includes water bodies such as ponds, lakes, channels, and embayments. For the purpose of systems classification, the natural levees above 5 ft in elevation are considered to be upland while those below 5 ft are called wetland. Backswamps and marshes can be either freshwater wetlands (palustrine) or nonfresh wetlands (estuarine). The vegetated dunes on beaches and cheniers are considered to be upland when they are above 5 ft in elevation, or when they are designated on USGS topographic maps by a green area without a swamp pattern. Water bodies occur in five systems with salinity being one of the major factors determining the associated aquatic species.

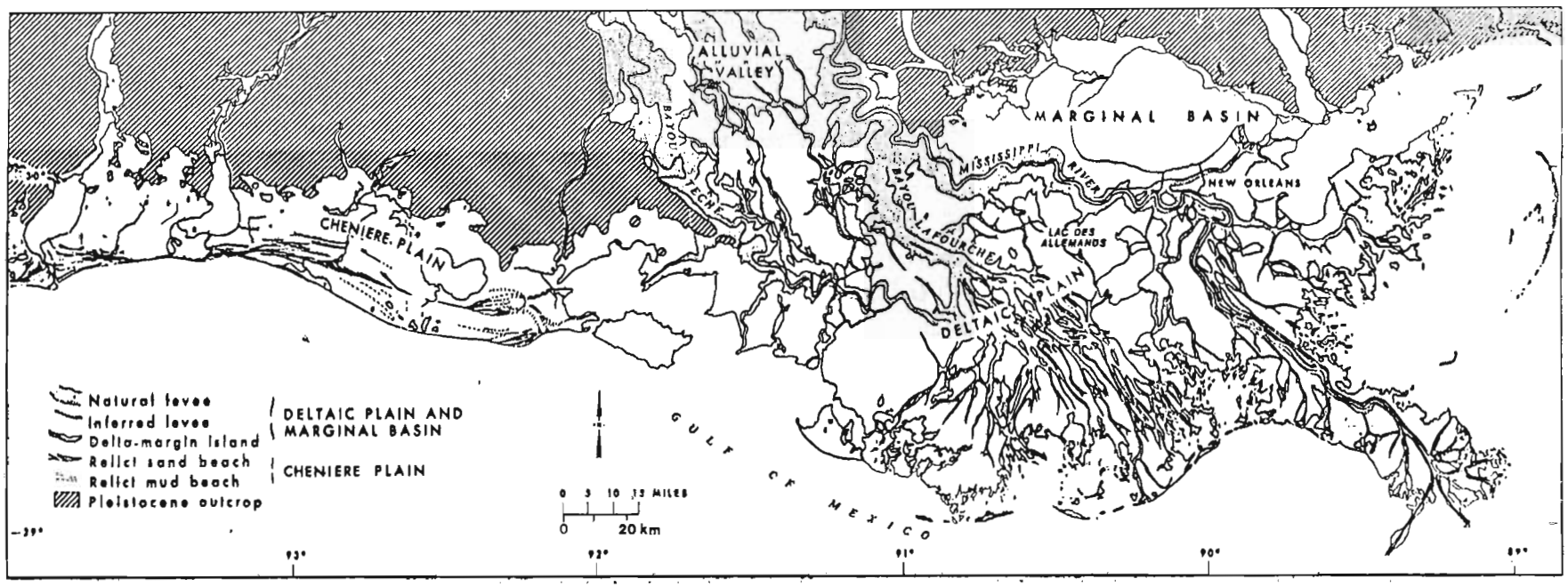


Figure 10. Major physiographic regions in coastal Louisiana (after Gagliano and van Beek 1970).

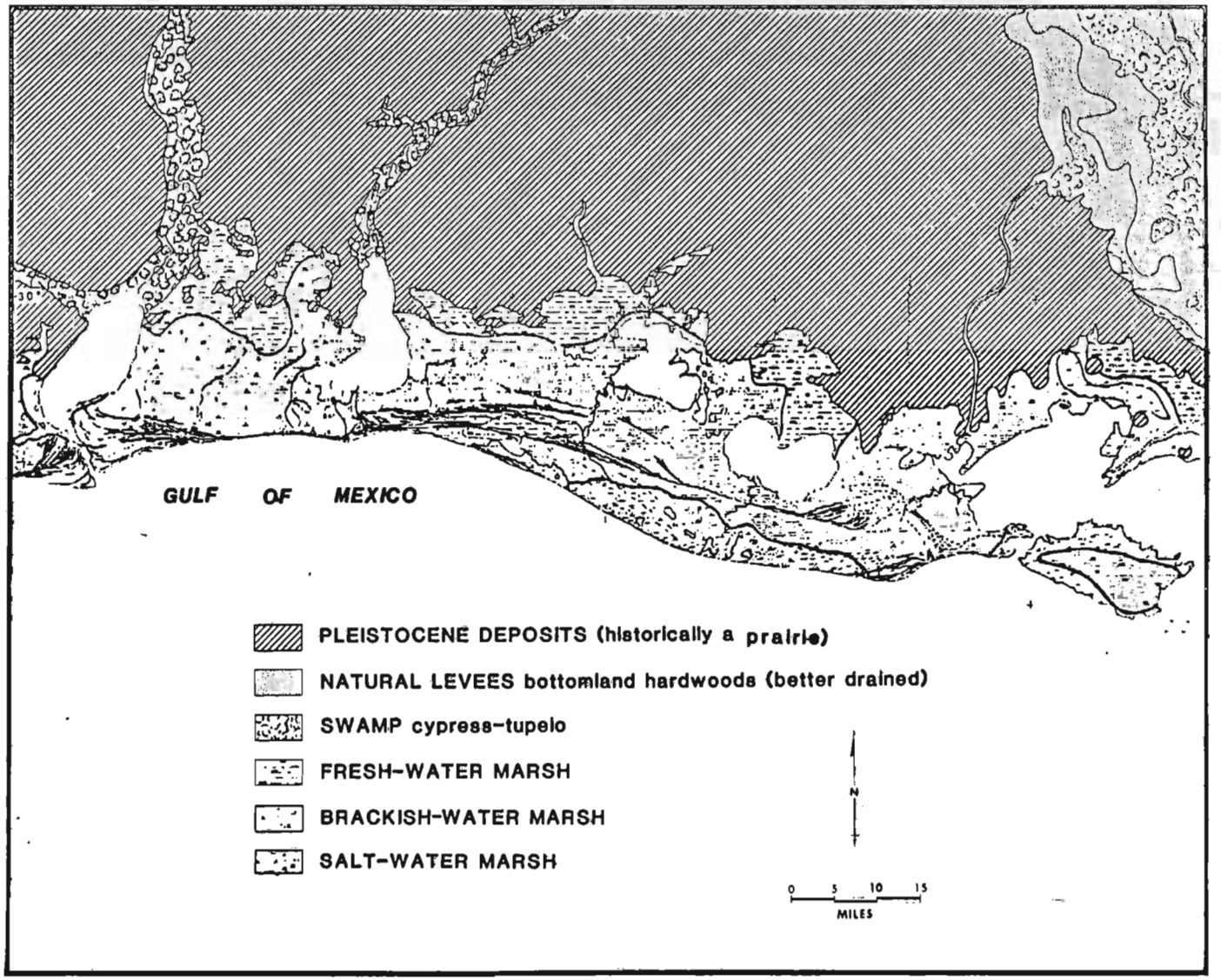
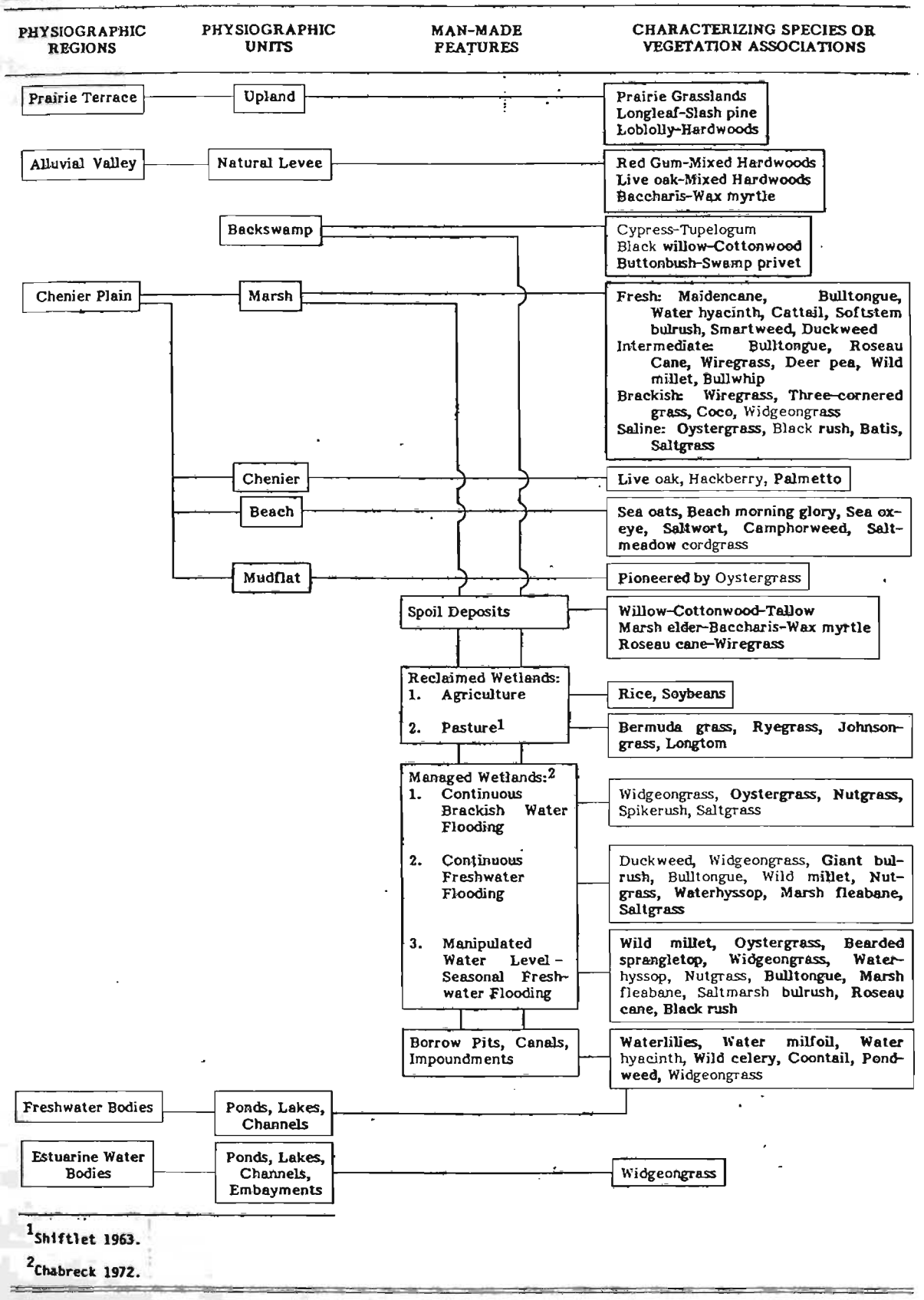


Figure 11. Major vegetation associations in the Chenier Plain Region (after Gagliano and van Beek 1970).

Table 6. Relationship among Physiographic Regions, Physiographic Units, Man-Made Features, and Vegetation in the Chenier Plain Region.



[1] Shiftlet 1963.

[2] Chabreck 1972.

While seven physiographic units are present in the Chenier Plain, those covering the largest area are marshes and shallow water bodies. Beaches and mudflats are very limited in extent and occur primarily along the marsh-Gulf interface. The backswamp is largely confined to the stretches of the narrow alluvial valleys of the Sabine, Calcasieu, Lacassine, and Mermentau, near the Prairie Terrace. The natural levees are small, low-lying segments of relict streams near the marsh-terrace interface and are very limited in area and distribution. In this study all beaches fall within the estuarine system and intertidal subsystem, while mudflats occur in the estuarine, palustrine, and lacustrine systems.

A knowledge of the species composition of the major vegetation associations within the Chenier Plain is essential for the classification of habitats to the subclass level. Species information is often apparent on CIR photos if the plant signatures (i.e., shape, color, texture, location) are distinctive. The identification of species' signatures must be made with field reconnaissance to verify photo interpretations or by photo comparisons with accurate, detailed vegetation maps. In this project, much of the terrestrial (upland) and swamp vegetation was field checked, while the marsh types were primarily derived from the field-annotated 15 and 7.5 minute base maps used to compile the Vegetative Type Map of the Louisiana Coastal Marshes (Chabreck and Linscombe 1978). Selected field checking of marsh and aquatic habitats was done to refine the marsh boundaries in areas impacted by man (i.e., spoil disposal sites and leveed marshlands). The vegetation on the low-lying natural levees in the Chenier Plain is characterized by live oak on the higher elevations and eastern baccharis on the lower elevations (Brown 1945) (Appendix 6). Spoil banks often have vegetation associations quite different from the rest of the environment in which they are located (Appendix 6). A recent study found that large, elevated spoil banks "contain terrestrial, upland plant species which are succeeding toward a bottomland hardwood forest" (Monte 1978: xvi). In areas where the spoil banks subside to former marsh levels, the successional process toward bottomland hardwood forest is reversed and marsh species reclaim the former spoil sites. Eastern baccharis, a common shrub along channel and lake banks in the marsh, often remains for extended periods of time to mark the former spoil deposits (Brown 1945; Spindler and Noble 1974).

A swamp is "a woody community occurring in an area where the soil is usually saturated or covered with surface water for one or more months of the growing season" (Penfound 1952:415) (Table 7). In the Chenier Plain Region all swamps are

Table 7. List of Major Types of Southern Freshwater Swamps.

DEEP SWAMPS:

Freshwater, wood communities, with surface water throughout most or all of the growing season.

a. Southern cypress - tupelogum
(Taxodium distichum - Nyssa aquatica)

b. Swamp gum - pond cypress
(Nyssa biflora - Taxodium ascendens)

SHALLOW SWAMPS:

Freshwater, transitional woody communities, the soil of which is inundated for only short periods during the growing season.

a. Black willow - sandbar willow
(Salix nigra - Salix interior)

b. Buttonball - dogwood - willow
(Cephalanthus - Svida - Salix)

c. Overcup oak - water hickory
(Quercus lyrata - Hicoria aquatica)

d. Hackberry - elm - ash
(Celtis - Ulmus - Fraxinus)

e. Maple - red gum - oak
(Rufacer - Liquidambar - Quercus)

f. Alder - birch
(Alnus - Betula)

PEATY SWAMPS:

Oxylic, peat-forming, sclerophyllous woody communities, with surface water only during a part of the growing season.

a. Red bay - sweet bay
(Tamala pubescens - Magnolia virginiana)

b. Pond pine - slash pine
(Pinus serotina - Pinus caribaea)

c. Southern white cedar
(Chamaecyparis thyoides)

d. Evergreen shrub swamp
(Ilex - Cyrilla - Zenobia)

Source: Penfound 1952.

freshwater and fall under the palustrine system. Swamps composed of trees are within the forested class while those consisting of scrub/shrubs are in the scrub/shrub class. The swamps along rivers and bayous in the Chenier Plain Region are predominantly the cypress-tupelogum association (Brown 1945) (Appendix 6) with a 2 and 1 subclass label respectively. These species frequently occur in the same area but are usually grouped in pure, even-aged stands (Mattoon 1915). Pure stands of tupelogum are considered to be a result of the selective cutting of baldcypress in the region (Putman 1951). While cypress-tupelogum swamps were never extensive in the Chenier Plain Region, the area was an initial lumbering site. Lake Charles, located on the Calcasieu River, was the first major logging and lumbering center in Louisiana, and logs were floated down the Calcasieu River to the town (Gosselink et al. 1979; Stokes 1954).

A marsh, like a swamp, constitutes an "area where the soil is usually saturated or covered with surface water for one or more months of the growing season" (Penfound 1952:415). Unlike a swamp, a marsh consists of a grass-sedge-rush rather than a woody community, and falls under the class - emergent. No subclass label was given to fresh marsh species because this marsh zone contains a variety of species of various subclass labels which requires intensive field checking to verify prior to air photo interpretation. The nonfresh marshes are composed primarily of narrow-leaved, persistent species and are therefore labeled "5" in the subclass. The salinity ranges for the major marsh types in Louisiana vary according to different authors (Table 8), but for the Chenier Plain marshes, the average given for a saline marsh is 12 ppt; for a brackish marsh, it is 5.1 ppt; and for a intermediate marsh, it is 2.2 ppt (Gosselink et al. 1979) (Figure 12). The Chenier Plain's four major marsh types and typical plant species are as follows:

Saline:	Spartina alterniflora (oystergrass) Distichlis spicata (saltgrass) Scirpus robustus (leafy three-square) Spartina patens (wiregrass) Batis maritima (batis)
Brackish:	Spartina patens (wiregrass) Distichlis spicata (saltgrass) Scirpus olneyi (three-cornered grass) Paspalum vaginatum (paspalum)
Intermediate:	Spartina patens (wiregrass) Phragmites australis (roseau cane) Sagittaria falcata (bulltongue) Scirpus olneyi (three-cornered grass) Paspalum vaginatum (paspalum) Echinochloa walteri (Walter's millet) Alternanthera philoxeroides (alligatorweed) Cyperus odoratus (cyperis)

Table 8. Salinity Values Recorded by Various Investigators for Coastal Wetlands.

INVESTIGATOR	SALINITY (in ppt) OF MARSH TYPES			
	FRESH	INTERMEDIATE	BRACKISH	SALINE
Penfound and Hathaway 1938	<5	NA*	5 - 20	20+
O'Neil 1949	<5	NA	0.7 - 18.0	18+
Allan 1950	0 - 1.0**	0.8 - 3.5	NA	3.0 - 5.0
Chabreck 1968	1.09 - 6.66	2.71 - 2.77	4.67 - 18.39	0.63 - 29.57
USACE 1974	0 - 5	5 - 10	10 - 20	20+
Montz 1976	0 - 1	1 - 8	8 - 18	18+
Cowardin et al. 1979	<0.5	0.5 - 5	5 - 18	18 - 30
USDA/SCS N.D.	0 - 5	0.39 - 9.80	0.42 - 28.08	0.62 - 51.88

* No data available.

** Data given in % salinity.

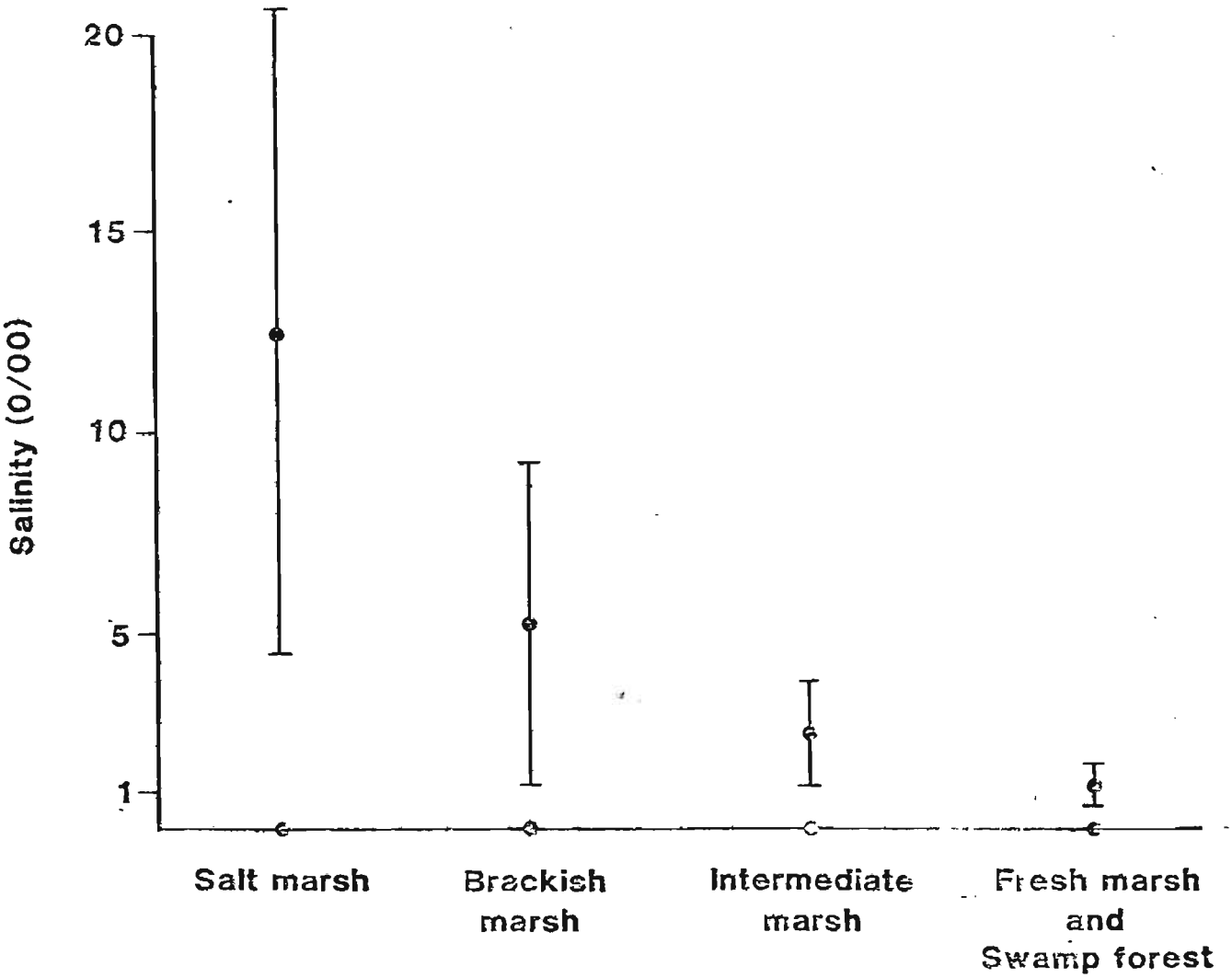


Figure 12. Water salinities (mean ± standard deviations) in five natural habitats in the Chenier Plain Region (after Chabreck 1972, modified by Gosselink et al. 1979).

Fresh:	Panicum hemitomon (maidencane) Sagittaria falcata (bulltongue) Eleocharis spp. (spikerush) Alternanthera philoxeroides (alligatorweed) Spartina patens (wiregrass)

Source: Chabreck 1972; Chabreck and Linscombe 1978.

(See Appendix 6 for a complete list of species recorded in Hydrologic Units VIII and IX.)

Three of these marsh types are further identified as to tidal regime and water chemistry. The intermediate and brackish marsh zones experience an irregular tidal regime (P), while the saline marsh zone is flooded regularly (N). The salinity values of these marsh types are identified by the coastal halinity modifiers:

Saline = polyhaline (4)
Brackish = mesohaline (5)
Intermediate = oligohaline (6)

The marsh type boundaries and species composition have changed over the past 27 years. Fresh marshes were more extensive in the late 1940s (O'Neil 1949) (Figure 13) and the sawgrass (Cladium jamaicense) association was a major component of the fresh marsh type (O'Neil 1949) (Appendix 6). Saltwater flooding of much of the Chenier Plain marshes by the Hurricane Audrey storm-surge in 1957 and subsequent droughts were major factors in the deterioration of approximately 162,000 ac (65,610 ha) of sawgrass marsh in the northern reaches of the fresh marsh zone (Valentine 1976) (Figure 13). This was a deep, freshwater marsh with water level ranges of +4 to +15 in. For a variety of reasons, this extensive sawgrass association has not reestablished itself, and recent vegetation surveys (Chabreck 1972; Chabreck and Linscombe 1978) (Figure 14) do not list sawgrass as a major species in the fresh marsh zone.

Extensive areas of the Chenier Plain wetlands have been modified by the construction of canals and/or levees. In an attempt to more accurately describe existing and former marsh habitat types, modifiers were used to distinguish the landuse in addition to the marsh type. For example, marshes that were ditched and partially drained but still supported wetland plants were identified by the modifer "d." Wetlands that were ditched and leveed and in which water levels were managed, usually for waterfowl and

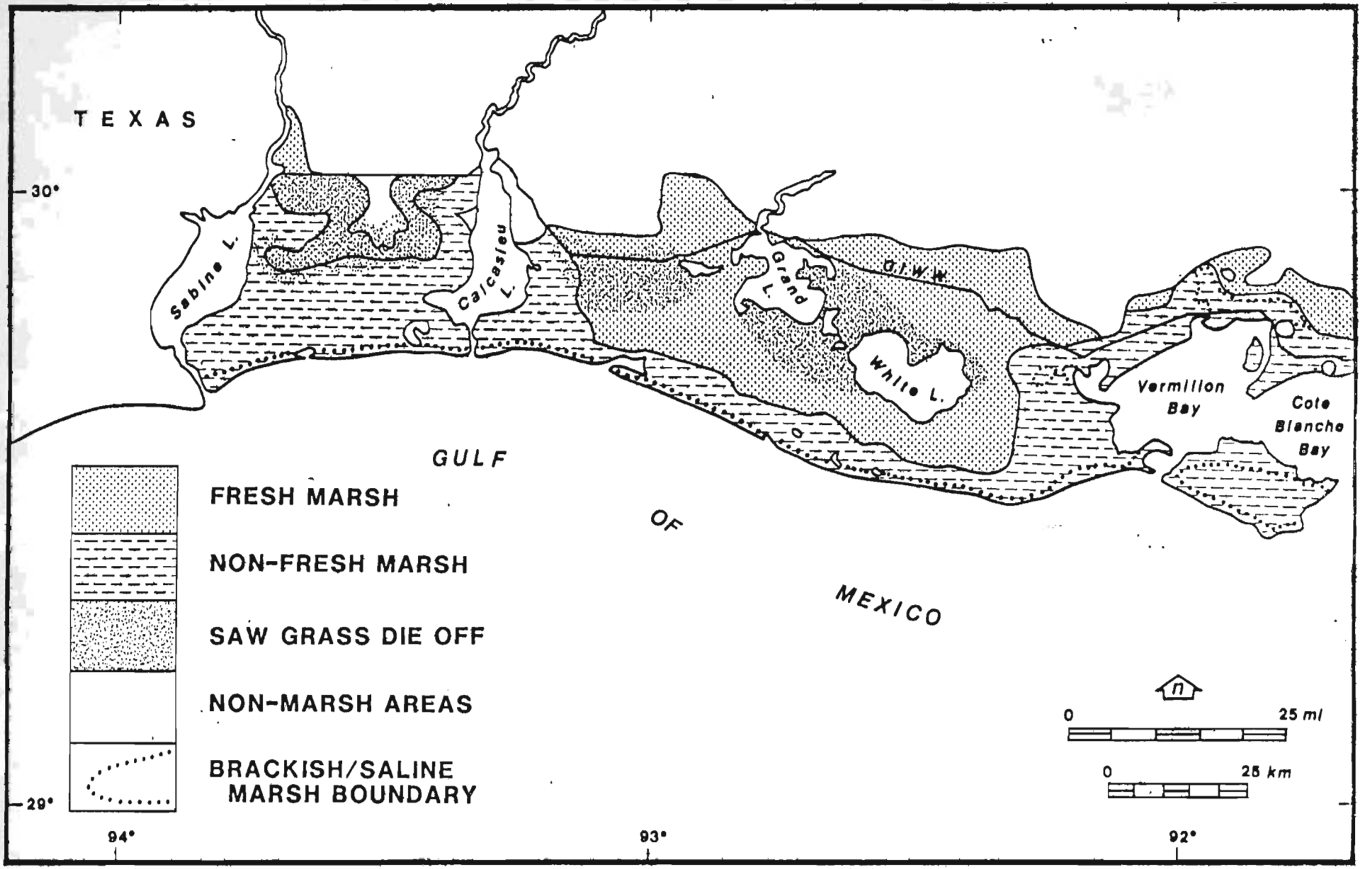


Figure 13. Approximate boundaries of the fresh and nonfresh marshes in the Chenier Plain Region in the late 1940s (after O'Neil 1949; approximate location of sawgrass die-off from Valentine 1976).

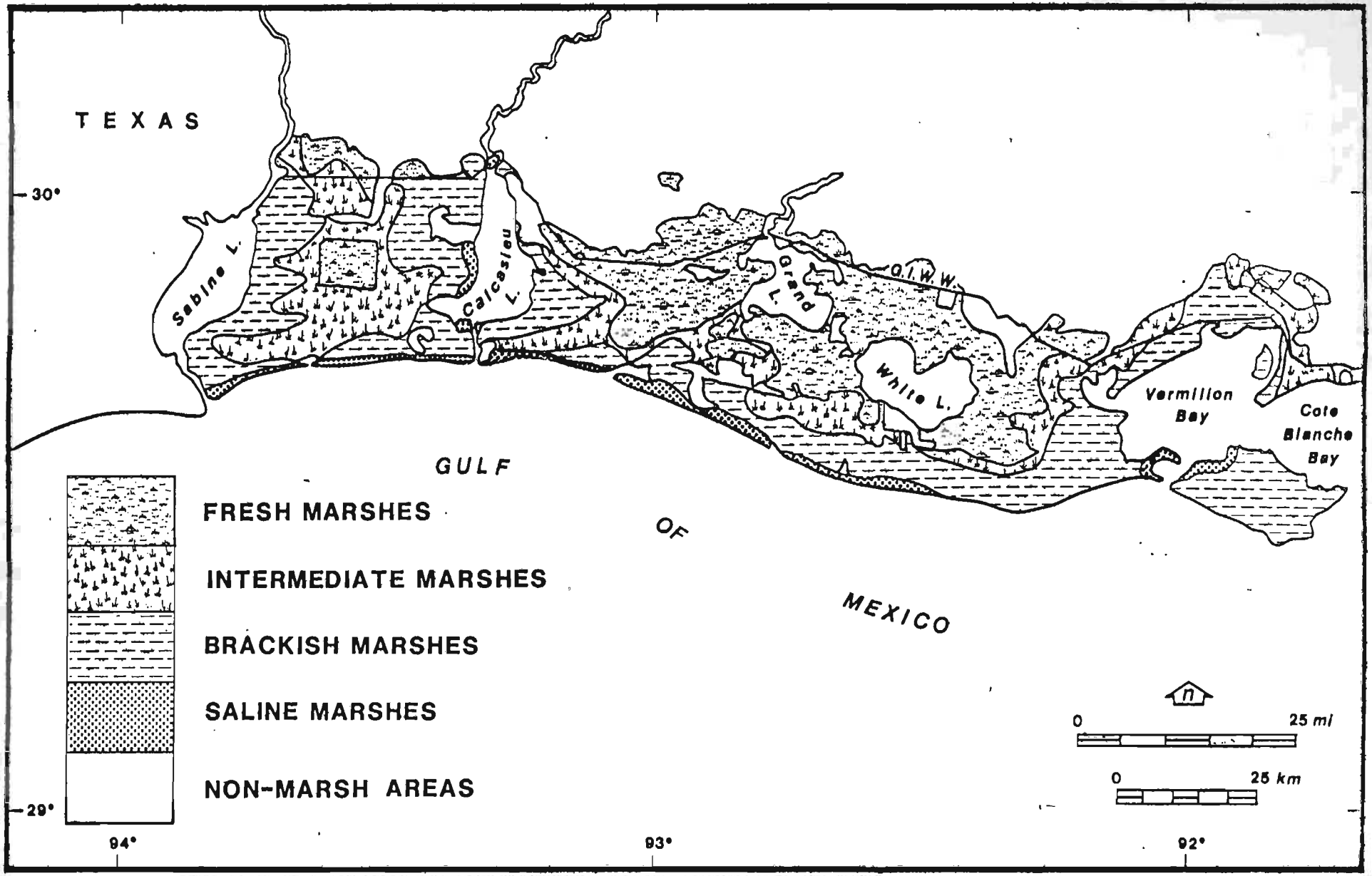


Figure 14. Approximate boundaries of the fresh, intermediate, brackish, and saline marshes in the Chenier Plain Region in 1978 (after Chabreck and Linscombe 1978).

furbearers, were labeled "m." If the wetlands were ditched and leveed but appeared to be flooded and breaking up because of lack of management (i.e., abandonment of maintenance of levees and water control structures), they were identified by the modifier "w." Former marshes that were ditched and leveed and drained sufficiently to permit agriculture, including rice, or which appeared to be well-drained pasture, were labeled "e" for reclaimed.

Beach dunes along the southern perimeter of the Chenier Plain, inland of the beach zone, were initially identified from USGS topographic maps when they were above 5 ft in elevation and were classified in the upland system and grassland (GR) class. The modifier "p" was used to identify this grassland as a beach dune association. On CIR photos, the dune vegetation (Appendix 6) had a coarser texture, a darker red color, a ruffled perimeter, and trended in a linear direction roughly parallel to the beach. Areas less than 5 ft in elevation having these characteristics and located near the Gulf shore were also identified as beach dunes. Beaches and mudflats, when exposed, appeared to have little or no vegetation and are discussed in the section of this report pertaining to unvegetated habitats without structures. In some instances, where mudflats were being pioneered by emergent species, the flats appeared to be dark greyish-green with flecks or scattered patches of pinkish-colored vegetation.

Cheniers are abandoned, vegetated beach ridges easily distinguished on CIR photographs because of their long, narrow, linear shape, often with inland curved ends. They are considered to be in the upland system because they are well drained. The location of cheniers has been documented by USGS topographic maps and numerous authors (Byrne et al. 1959; Gosselink et al. 1979; Gould and McFarlin 1959; Price 1954; Russell and Howe 1935). Because they have the highest elevations among the geomorphic features in the Chenier Plain, most cheniers have been extensively cleared for agriculture and development. The dominant natural vegetation (Appendix 6) is live oaks whose linear alignment, dark red color, and round crown shape contrast sharply with the marsh vegetation signatures.

Cleared rights-of-way, often stretching for many miles, are usually made initially through tall vegetation, such as trees and shrubs, for construction of highways, pipelines, or power transmission lines. On CIR photos, they appear narrow, linear, and lighter in color and finer in texture than surrounding vegetation. Such areas can fall within either the upland or palustrine system and, therefore, have no subsystem.

Because the vegetation is regularly maintained at a low level by man, the areas are considered to be within the developed class even though they are frequently vegetated by short grasses and/or shrubs.

Agriculture and pasture occur in all areas of the Chenier Plain Region and are usually relatively easy to recognize on CIR photos because of their well-defined field patterns with straight sides. These areas are considered to be in the upland system and developed class because they are manipulated by man. The subclass label "2" is a general category including all types of crops and pasture. Agriculture and pasture land that has been reclaimed from marshland is further distinguished by the modifier "e." The color of agriculture and pasture varies depending upon the crop and field condition. Dry, bare fields are whitish, while wet, bare fields are dark grey-green to dark blue. Young, green crops are fine-textured and range from dark red to pink, while older crops have a fine-to-medium texture and a pink-to-yellowish color. Most agricultural fields display plow scars or crop row patterns, and rice fields are very distinctive because of the long, narrow, sinuous row mounds segmenting the fields into sections for flooding. Pasture often has a coarser texture than crops because of the heterogeneous species composition, especially if it occurs in reclaimed wetlands and is not extensively cultivated.

Aquatic beds composed of submerged aquatic plants are generally confined to water depths of less than 6 ft (1.8 m) and are not usually visible on aerial photographs. The water body in which aquatic beds (floating, floating-leaved, and submergent) are located determines their system and subsystem, while their species composition determines their class and subclass. They were only mapped in this study according to field reconnaissance and personal communication and therefore appear less well-distributed in the Chenier Plain Region than they probably are. Floating and floating-leaved aquatics are highly visible on CIR photos. For example, on CIR photos, hyacinths and duckweed (both floating aquatics) appear bright red to pink, have a smoother texture than adjacent vegetation, and often totally cover a small body of water. Floating-leaved aquatic beds, such as waterlilies, appear pink, are coarser in texture, and often have a rounded mat- or fan-shaped appearance. They do not shift position like hyacinths and duckweed and are generally confined to freshwater habitats. Floating aquatics are characteristic of fresh surface waters, but can be found in tidally influenced estuarine waters where they have been flushed by flood waters or strong offshore winds. Most floating aquatics in the Chenier Plain Region die and sink below the surface during winter freezes. They are usually visible only on

late spring through mid-fall imagery. The distribution of both submerged and floating plants is subject to constant change in response to predation, disease, storms, human eradication, and, in some instances, altered salinity regimes. For a listing of species commonly found in fresh and fresh-to-slightly-brackish waters, see Appendix 6.

Because aquatic beds are extensively distributed in freshwater areas, much of their mapped distribution on the habitat maps is confined to clearly defined channels and larger ponds, lakes, and impoundments. It was not considered feasible to map floating aquatics in the interstices of freshwater marshes. If it was not possible to determine the subclass of an aquatic bed (i.e., floating, floating-leaved, submerged algal or vascular, and pioneer) the habitat was only labeled to the class level. The distribution of all submerged and floating aquatics throughout the entire Chenier Plain Region has not been mapped. Montz (1979, ongoing research) is presently preparing a study on the distribution of submerged vegetation in coastal Louisiana.

Summary of Habitat Types and Identifying Characteristics

Fifty-four vegetated habitats occurring in five systems and seven classes were discerned within the Chenier Plain Region. Some habitats were natural and others were influenced by actions of man. A list of these habitats including their map symbols and major identifying characteristics is illustrated in Table 9. For a more detailed description of each of these habitats, see Appendix 5 where the habitats are listed by their alphanumeric symbols. A schematic diagram of the labeling methodology used in this study is illustrated in Figure 15 which shows a cross section of the topography and associated vegetation that are typically located between the Prairie Terrace and the Gulf of Mexico.

Initial air photo interpretation evaluates texture, shape, and size to determine the vegetation association's class: trees, shrubs, grasses, or aquatics. Secondarily, the vegetation's location determines its system: i.e., upland or wetland, fresh or nonfresh (intermediate, brackish, saline) and, in the case of aquatic beds, whether they are in an intermittent, lower perennial, or tidal regime. Identification of vegetated habitats to the subclass level requires a knowledge of the species composition which must be obtained from a variety of sources, including field reconnaissance and detailed vegetation maps. Modifiers were used primarily to indicate man-influenced habitats, such as spoil and reclaimed areas.

Table 9. Vegetated Habitats and their Defining Characteristics.

SYMBOL	DEFINITION/ NAME	LEAF STRUCTURE									VEG. HEIGHT			HYDROLOGIC AND SALINITY CHARACTERISTICS								ORIGIN	
		BROAD-LEAVED DECIDUOUS	NEEDLE-LEAVED DECIDUOUS	BROAD-LEAVED EVERGREEN	NEEDLE-LEAVED EVERGREEN	SUBMERGED VASCULAR	FLOATING	FLOATING LEAVED	UNDETERMINED	POWER	NARROW-LEAVED PERSISTENT	> 20 FT	< 20 FT	ESTUARINE REGULAR TIDAL	ESTUARINE IRREGULAR TIDAL	ESTUARINE SUBTIDAL	RIVERINE TIDAL	RIVERINE LOWER, PERENNIAL	LACUSTRINE<6 FT, >20/AC	PALUSTRINE<20/AC	PALUSTRINE WET	UPLAND NONFLOODED	NATURAL	MAN-IMPLANTED
PSS1	Shrubs	X											X								X		X	
PSS1/2	Shrubs	X	X										X								X		X	
PSS1/3	Shrubs	X		X									X								X		X	
PSS2	Shrubs		X										X								X		X	
PFO1/2	Trees	X	X									X									X		X	
PFO1/3	Trees	X		X								X									X		X	
PFO1/2/3	Trees	X	X	X								X									X		X	
PFL5	Flat									X	X		X								X		X	
PAB5	Floating Aquatics						X						X							X			X	
PAB5h	Floating Aquatics						X						X							X				X
PEM	Fresh Marsh										X		X								X		X	
PEMd	Fresh Marsh Ditched										X		X								X			X
PEMm	Fresh Marsh Managed										X		X								X			X
PDV	Cleared Right-of-Way								X				X								X			X
L3FL5	Flat									X	X		X						X				X	
L7AB	Aquatic Bed								X										X				X	
L3AB5	Floating Aquatics						X						X						X				X	
L3AB5h	Floating Aquatics						X						X						X					X
R1AB	Aquatic Bed								X				X				X						X	
R1AB5	Floating Aquatics						X						X				X						X	
R1AB5x	Floating Aquatics						X						X				X							X
R1AB5o	Floating Aquatics						X						X				X							X
R1AB5o	Floating Aquatics						X						X					X						X
E1AB	Aquatic Bed								X				X			X							X	
E1AB2	Submerged Aquatics					X							X			X							X	
E1AB5	Floating Aquatics						X						X										X	
E1AB5x	Floating Aquatics						X						X											X
E1AB5h	Floating Aquatics						X						X											X
E1AB5o	Floating Aquatics						X						X											X
E2FL5	Flat									X	X													X
E2EM5P5	Brackish Marsh										X		X		X								X	
E2EM5P5d	Brackish Marsh Ditched										X		X		X									X
E2EM5P5m	Brackish Marsh Managed										X		X		X									X
E2EM5P5w	Brackish Marsh Flooded										X		X		X									X
E2EM5P6	Intermediate Marsh										X		X		X								X	
E2EM5P6d	Intermediate Marsh Ditched										X		X		X									X
E2EM5P6m	Intermediate Marsh Managed										X		X		X									X
E2EM5P6w	Intermediate Marsh Flooded										X		X		X									X
E2EM5N4	Saline Marsh										X		X	X									X	
E2EM5N4d	Salipe Marsh Ditched										X		X	X										X
E2EM5N4s	Saline Marsh Man-Made										X		X	X										X
USS1	Shrubs	X											X									X	X	
USS1s	Spoil w/shrubs	X											X									X		X
USS1/3	Shrubs	X		X									X									X	X	
USS1/3s	Spoil w/shrubs	X		X									X									X		X
USS1/3/4	Shrubs	X		X	X								X									X	X	
UFO1s	Trees	X										X										X		X
UFO1/3	Trees	X		X								X										X	X	
UFO1/3/4	Trees	X		X	X							X										X	X	
UFO3	Trees			X								X										X	X	
UDV	Cleared Right-of-Way								X				X									X		X
UDV2	Agriculture/ Grassland												X									X		X
UDV2s	Sociajmed Agri.-Grass.												X									X		X
UGRp	Beach Dune Grass												X									X	X	

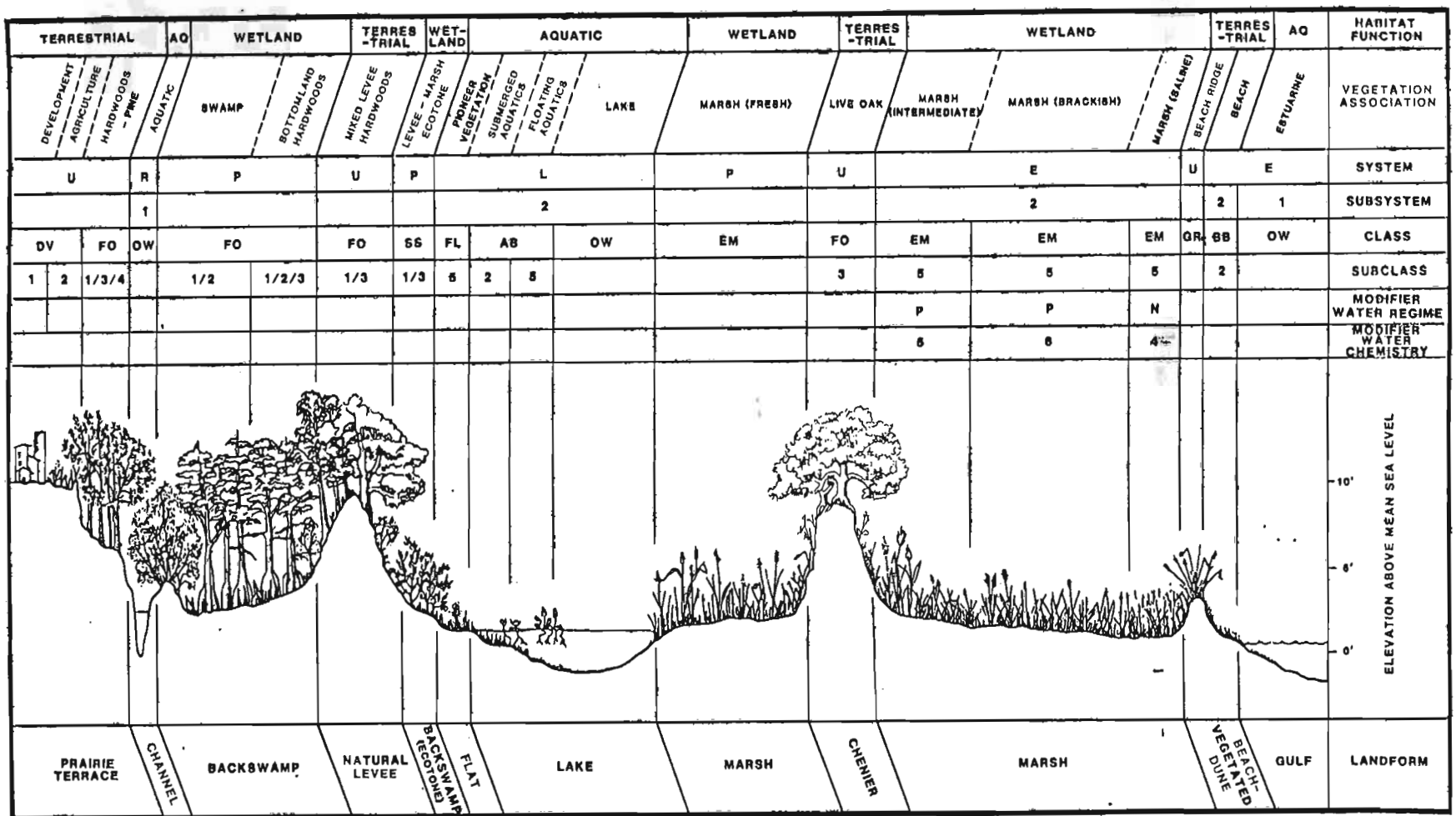


Figure 15. Relationship of habitat and vegetation associations to landforms in the Chenier Plain Region.

Unvegetated Habitats without Structures

Identification on Aerial Photographs

Unvegetated habitats without structures are readily recognizable on CIR photos because of their color, texture, location, and relatively consistent planimetric geomorphic shape. There are five classes (flat, unconsolidated bottom, beach/bar, reef, and spoil/bare ground) of unvegetated habitats without structures. Flats and unconsolidated bottoms are colored light to dark greyish-green, while beaches, reefs, and spoil/bare ground are usually a glaring white. All of these habitats are smooth textured and are located in or near water bodies. Only the spoil/bare ground habitat is sometimes located in areas removed from water bodies.

Most unvegetated flats are usually visible on photographs only during periods of low water. Flats are more irregular in shape than beaches and are usually situated in low-wave energy environments, such as behind beaches and bars and in interior wetlands experiencing vegetation "die-backs." Beaches and bars are relatively narrow, usually linear or lenticular in shape, and are located along a land-water interface. Beaches are found along the Gulf and interior large lakes, and bars are frequently found in river channels. Only the more elevated or intertidal reefs, generally confined to shallow, estuarine areas and tidal passes, are visible on CIR photos as narrow, short, linear, irregular-sided masses of shell (mostly oyster [Crassostrea virginica]). Spoil disposal sites are usually adjacent to dredged channels and land clearings, and fill sites are associated with development activities.

Flats consist of poorly sorted, fine- to medium-grained mineral and organic matter in low-wave energy environments. There are extensive mudflats in the Chenier Plain Region around the mouth of Sabine Pass, Calcasieu Pass, and the Mermentau River resulting from the littoral transport and deposition of fine-grained sediment near the jetties of the two passes and the mouth of the river. However, marsh grasses quickly pioneer these areas and only the most recently deposited, intermittently exposed perimeters were labeled as mudflats. Mud- and mud/organic flats are also very prevalent in interior wetlands experiencing marsh breakup. Sand flats appear as small, usually linear pockets of washover material in low-lying marsh areas behind the beach dunes.

Unconsolidated bottoms are composed of relatively unsorted, loose mineral and/or organic material. These areas are commonly found along the shore of the Gulf and interior large lakes. Within the coastal zone, wave-cut terraces along the marsh-water interface that were bare of vegetation and intermittently exposed were considered to be unconsolidated bottoms.

Beaches and bars, located in higher energy environments, are exposed at low water levels and are composed of well-sorted sand and/or shell particles. The majority of the beaches in the Chenier Plain are located along the shores of the Gulf of Mexico.

In the Chenier Plain Region, reefs consist of a cemented, living and/or dead shell infrastructure with mineral and organic material in the interstices. Reefs are found in tidal passes near the Gulf, especially in the southern portion of Calcasieu Lake.

Spoil/bare ground habitats have been cleared of vegetation by the actions of man which include disposal of dredged material and waste material and bulldozing. This latter habitat type is often an ephemeral feature that will be vegetated or developed eventually. However, these sites were often extensive, as with the land clearing and spoil disposal east of the Sabine River, and were identified as a separate habitat type on the 1978 CIR photos.

Most of these features are shown on USGS topographic maps with symbols or patterns identifying the habitat form (i.e., class) and composition (i.e., subclass). These serve as a collateral data source when they are of the same approximate date as the photographs or when there has been little geomorphic change in the area.

Classification of Habitat Type

All of the unvegetated habitats without structures, except for spoil/bare ground which is in an upland system, are associated with water bodies and acquire the system (palustrine, lacustrine, estuarine) and subsystem (intertidal or littoral) designations of the water bodies in which they are found. The habitat class is determined by the feature's geomorphic shape (i.e., flat, unconsolidated bottom, beach/bar, reef, and spoil/bare ground). Each habitat class is further defined to subclass level according to its specific material composition (i.e., mollusc shell, sand/shell, mud, and organic).

Only the spoil/bare ground class has a broader, generic, subclass label of unvegetated land/spoil/disposal sites.

Summary of Habitat Types and Identifying Characteristics

There are 10 unvegetated habitats without structures in the Chenier Plain Region: 6 are flats while the rest are unconsolidated bottom, beach/bar, reef, and spoil/bare ground (Table 10). All of the habitats are natural except one (spoil/bare ground) which is the result of man-related activities involving landfill, land clearing, and/or the deposition of dredged material.

Table 10. Unvegetated Habitats without Structures and their Defining Characteristics.

		SIZE				SHAPE		SALINITY		WATER REGIME			COMPOSITION				ORIGIN	
SYMBOL	DEFINITION/NAME	> 20 AC	< 20 AC	> 6 FT	< 6 FT	LINEAR	NONLINEAR	FRESH	ESTUARINE	TIDAL	LOWER PERENNIAL	INTERMITTENT	SAND	SHELL	MUD	ORGANIC	NATURAL	MAN-MADE
PFL3	Flat		X				X	X							X		X	
L2FL3	Flat	X			X		X	X							X		X	
L2FL3/4	Flat	X			X		X	X							X	X	X	
E2FL3	Flat	X	X			X	X		X	X					X		X	
E2FL3/4	Flat	X	X			X	X		X	X					X	X	X	
E2FL3h	Flat	X	X			X	X		X	X					X			X
E2UB3/4	Unconsolidated bottom						X		X	X					X	X	X	
E2BB2	Beach					X	X		X	X			X	X			X	
E2RF2	Reef					X	X		X	X				X			X	
UDV3	Unvegetated ground					X	X											X

Unvegetated Habitats with Structures

Identification on Aerial Photographs

Unvegetated habitats with structures are all man-made habitats that are easily recognized on CIR photos because of their color, texture, pattern, size, shape, and location. These features are also identified on USGS topographic maps which serve as excellent sources of collateral information if they are as recent as the photographs. The five unvegetated habitats with structures include jetties, urban-industrial areas, flood-protection levees, roads/railroads, and mineral mining sites. Jetties are greyish white in color and have a very narrow, short, linear shape. They are usually found in shallow, nearshore waters perpendicular to the shore or extending seaward, often in parallel pairs, to confine the mouth of a river, as at Sabine and Calcasieu Pass, and maintain the channels' depth. In most cases, jetties that are visible as thin lines, often altering wave patterns on air photos, are also labeled on USGS topographic maps. While jetties may have attached flora, their purpose is to serve as control structures for water flow and wave action, and vegetation is not visible on the imagery.

Urban-industrial areas, protection levees, roads, and mining sites appear smooth textured and light grey to white because of the reflection of light from bare ground, shell, gravel, concrete, and building surfaces. Their shapes are angular and blockish in the case of urban areas and mining sites, or curvilinear in the case of levees and roads. Roads are also identified by their interchanges, river crossings, and communities aligned alongside their route. Some protection levees or major levees around managed areas can be grass covered and appear red, but they are identifiable by their narrow, linear, enclosing shape and exterior, surrounding wetlands. They are also shown on USGS topographic maps by a standard levee symbol.

Classification of Habitat Type

With one exception, all unvegetated habitats with structures located in the Chenier Plain Region are considered to be man-controlled habitats in the upland system. Even though some may occassionally flood, they function as nonwetland habitat with no benefit to wildlife and are assigned to the developed class. For the purpose of this study, all landuses within the upland system and developed class were grouped into one subclass defined as urban/residential/commercial/industrial and labeled UDV1. No

attempt was made to distinguish among urban, industrial, commercial, and residential habitats. Many individual features, such as housing clusters, were often grouped with roads and levees and outlined and labeled as a single habitat unit. Conspicuous levee systems for flood protection and water level control were often outlined separately and labeled UDV1. Some industrial sites related to mineral industries, such as oil tank farms and drilling complexes, were given a modifier "o" to distinguish them from other developed areas. These sites were identified only with the aid of air photos and topographic maps, and some mineral-related developments may have been omitted in the absence of collateral information. Roads connecting oil drilling sites were also labeled UDV1o.

Jetties are the previously mentioned exception. They are man-made, usually composed of boulders, and their location along the nearshore Gulf places them in the estuarine system and intertidal subsystem. They constitute an artificial (modifier), rocky shore (class) composed of boulders (subclass).

Summary of Habitat Types and Identifying Characteristics

There are five unvegetated habitats without structures in the Chenier Plain Region (Table 11). One, jetties, constitutes a man-made structure in an estuarine, intertidal environment, while four constitute upland systems in the developed subclass. Three of the habitats (urban-industrial, protection levees, and roads/railroads) were delineated and labeled on the habitat maps as being within the same subclass because they function as nonwetland, nonwildlife habitat and did not need to be defined separately for the purpose of this study. Developments associated with the mineral industry, especially petroleum-related roads and drilling sites in wetlands, were delineated where possible because part of the purpose of this study was to determine the extent of oil and gas industrial activity in coastal Louisiana.

Table 11. Unvegetated Habitats with Structures and their Defining Characteristics.

SYMBOL	DEFINITION/ NAME	SHAPE		WATER REGIME		ORIGIN	
		LINEAR	IRREGULAR	FRESH TIDAL	ESTUARINE INTERTIDAL	NATURAL	MAN-MADE
E2RS2r	Jetty	X			X		X
UDV1	Urban-Industrial Protection Levees Roads-Railroads	X	X				X
UDV1o	Mineral Industry	X	X				X

CHAPTER III: MEASUREMENT AND RECORDING OF DATA

Habitat Measurement and Data Compilation

In addition to compiling a series of 1978 7.5 minute habitat maps of the Chenier Plain, a major objective of the study was the compilation of habitat area according to State, parish, topographic, Coastal Zone (Act 361), and hydrologic units. This information was stored on a computer tape for subsequent analysis of habitat area. The following discussion describes the method of habitat measurement and data storage.

When the habitat maps on mylar had been completed and verified as to their accuracy, areal measurements of the habitats were made using a Numonics Model 1224 electronic digitizer. This unit contains an optical pick-up system which detects linear changes in two dimensions and translates this information into either linear or areal values. The electronic planimetering of each habitat map was performed by a two-member team—one person manipulated the digitizer and read the measurements while an assistant recorded the habitat area on a standardized work sheet (Figure 16). The assistant also kept track of the planimetering process by color-coding a blue-line copy of the habitat map as each habitat area was measured.

The steps followed in planimetering the 1978 Chenier Plain Region habitat maps are as follows:

1. The scaling factors were programmed into the digitizer and the resulting performance was checked against a standard.

2. The total area of the draft map was determined by averaging three point-to-point measurements of the vertices of the map border.

3. This figure was then divided by the USGS stable-base area value for the appropriate 7.5 minute quadrangle (Appendix 3), and the resulting proportionality constant was recorded on the digitizer worksheet (Figure 16).

WORKSHEET WORKSHEET

Quadrangle Name Grand Bayou, LA CEI Map No. M 213 - 78

Topographic Map Date 1934 Photo Source NASA

Sheet 1 of 1 Photo Date 1978

Quadrangle Stable base area 41,369 Quadrangle Measured Area 40747.6

TOTAL WITHIN STUDY AREA 40747.6 (POINT-TO-POINT) ① 40745.8 ② 40747.3 ③ 40749.9

	Subdivision 1 Hydrologic Unit 9 Parish CAMERON Primary Label E2EM5P5 Primary (total) Area 40747.6	Subdivision Hydrologic Unit Parish Primary Label Primary (total) Area

Label	Final Area	Work and Calculations	Final Area	Calculations
E10W	13065.1	937.8, / 2.2 1965.6, 2391.3, 576.7, 7192.1 /		
E10W$_t$	583.4	36.5, 538.5, 2.8, / 4.9, 0.7 /		
E10W$_o$	10.4	6.8, 2.7, / 0.9		
E10W$_x$	48.1	18.5, 11.4 / 18.2 /		
UDY2	4763.2	300.7, 567.9, / 3773.1, 121.5		
UDY1	537.6	265.5 / 17.0 8.7, 100.7, 23.1 / 48.3, 134.3,		
UFO 1/3	126.2	76.0, / 50.2 /		
US51/3	54.9	6.8, / 7.2, / 40.9		
UDY1$_o$	11.1	3.4, / 4.3, 1.6, 1.8 /		
E2EM5P5d	486.1	170.5, 315.6 //		
POW$_x$	27.3	6.6 / 20.7 /		
UDY2e	2178.4	1018.8, / 1159.6 /		
E2BB2	208.1	208.1		
E2EM5P6	2269.1	2269.1 /		
E2EM5P6d	2738.3	2738.3 /		
US51$_s$	3.4	3.4, /		
POW$_h$	13.9	13.9, /		
E2FL3	11.9	11.9, /		
E1AB5	31.6	28.3, 3.3, /		
E2EM5N9	1008.9	1008.9 /		
E2EM5P5	12570.0	28177.6		

Digitized By JW, LJ, ZJ, ZT Date Oct. 2-3, 1980

Time to Complete 6.00

Figure 16. Example of the worksheet used in initial compilation of habitat areas.

4. If the topographic map unit contained additional subunits (i.e., State, parish, hydrologic unit, area inside and outside of the Coastal Zone boundary), each subdivision (i.e., unit) of the larger topographic map unit was measured continuously (Figure 17).

5. Primary areas of habitat types (e.g., large expanses of fresh marsh [PEM]) were measured from which all other labeled areas (usually smaller areas such as ponds [POW]) within them were subtracted (Figure 17).

6. Secondary areas of habitat types were then traced. If tracts belonging to a single habitat label were discontinuous, the accumulator feature was used to combine individual observations into a single value. Habitats of one type, entirely contained within a second type, could be subtracted from the second type by tracing in a counter-clockwise direction to yield negative areal values.

7. The length of linear geographic features; such as canals, roads, small streams, spoil, and levees; was measured and multiplied by the feature's standard width. These standard widths were obtained from collateral data sources.

8. After the area of each of the habitat types had been measured and recorded (Figure 16), the habitat outline was colored on the blue-line draft map (e.g., water bodies were coded blue, forests were coded green).

9. After each mylar draft habitat map had been measured and the areal information recorded on the worksheet, the map location was crossed off a master topographic index map used to monitor the planimetering process.

10. The areal information for each topographic map unit was transferred from the worksheet (Figure 16) to a final tally sheet (Figure 18) which was designed to show the data by habitat type and subdivision (i.e., State, parish, hydrologic unit, location inside or outside of the Coastal Zone boundary). Each subdivision contains two columns for each habitat type (i.e., digitized [planimetered] area and stable base area). The areal value obtained from measuring the habitat map was shown in the column labeled "digitized area."

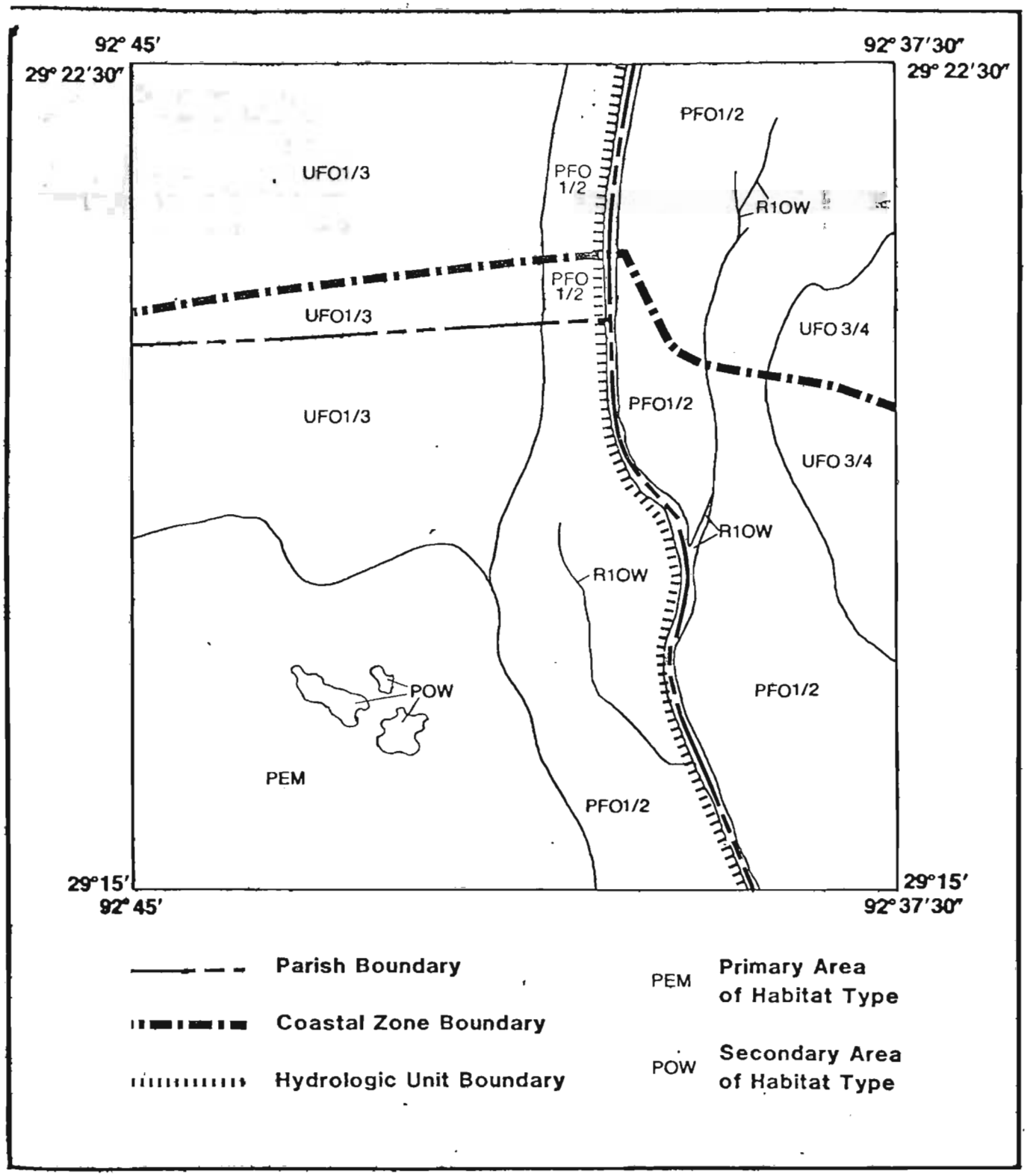


Figure 17. A diagram of a habitat map containing a Coastal Zone boundary, a parish boundary, and primary and secondary areas of habitat types.

Quadrangle Name: Grand Bayou, LA CEI Map No.: M213C:78

Topographic Map Date: 1934 Photo Source: NASA

Sheet: 1 of 1 Photo Date: 1978

Quadrangle Stable base area: 41,369.0 Quadrangle Measured Area: 40747.6

Subdivision	1
State Parish Code	LA CAMERO
Hydrol. Unit	9
Coastal Zone	1

LABEL	
E10W	13065.7
E10Wt	583.4
E10Wo	10.4
E10Wx	48.1
UDV2	4763.2
UDV1	537.6
UFO1/3	126.2
USS1/3	54.9
UDV1o	11.1
E2EM5P5d	496.1
POWx	27.3
UDV2e	2178.4
E2BB2	208.1
E2EM5P6	2,269.1
E2EM5P6d	2,738.3
USS1s	3.4
POWh	13.9
E2FL3	11.9
E1AB5	31.6
E2EM5N4	1008.9
E2EM5P5	12570.0
TOTAL AREA	40,747.6

Digitized By: J.W. & Z.J.T. Date: Oct. 2-3, 1980

Time to Complete: 6 hrs

Figure 18. Example of final tally sheet used in compiling habitat area measurements.

The corresponding "stable base area" was obtained by multiplying the digitized area by the proportionality constant (see item 3 above). Each of these calculations was performed twice to check mathematical accuracy.

11. The completed worksheet was checked for mathematical accuracy among "digitized area," total "point-to-point area," and "stable base area" of the map. Large discrepancies among the data at this stage led to examination or re-digitizing of the map to locate causes for the discrepancies and to correct them.

12. Data from the final tally sheet (Figure 18) were input onto computer files. The final product consists of one set of habitat areal measurements for the 1978 map series. This set contains 61 final tally sheets depicting 53 (7.5 minute) habitat map units covering land and 8 (7.5 minute) depicting open water area.

Data Summary Regarding Final Products

The Chenier Plain Region habitat mapping study recorded six types of information for the study area on both the habitat maps and the computer tape:

Information Type	Description
1. State	Louisiana
2. Hydrologic Unit	Units VIII and IX
3. Coastal Zone	Inside and Outside
4. Topographic Map	61 (see Appendix 3 for names)
5. Parish	Calcasieu Cameron Jefferson Davis Vermilion
6. Habitat Type	88 (see Appendix 5 for names)

The 61 habitat maps at a scale of 1:24,000 cover approximately 2,523,741 ac (1,022,115 ha) of land and water. However, portions of the eight topographic maps containing the Texas-Louisiana boundary were in Texas and were not mapped or measured. The northern tier of habitat maps (14 maps) in the study area contains land that is outside of the official Coastal Zone boundary. However, the portion of this area that is in Louisiana was interpreted, measured, and recorded on the final talley sheets as being outside the Coastal Zone boundary. The eastern limit of the study area contained four maps with land in Louisiana, but outside Hydrologic Unit VIII, the easternmost hydrologic unit in the study area. Habitats within this land area (in Hydrologic Unit VII) had been mapped and measured in a previous study (Wicker et al. 1980; Wicker 1980) and were not included in this study.

With the proper program, information recorded on the computer tape can be recalled to illustrate such things as the total area of the Coastal Zone in each parish, hydrologic unit, topographic map unit, or the entire Chenier Plain Region. The area of individual habitat types or a combination of habitat types can also be recalled according to the above subdivisions. Such information provides a useful data base for 1978 which can be used to document change once past or future habitat maps are made for the study area. The habitat maps are labeled according to the above subdivisions and provide a visual record of habitats by subdivisions and individual topographic map unit. These maps can be overlain on USGS topographic maps to compare habitat change or land loss between 1978 and the date of any given topographic map. However, it must be noted that the habitat map overlays may not align perfectly with the USGS topographic maps. This is due to distortion in the paper prints, slight scale changes when the maps are reproduced, alignment differences that are associated with the transfer of data from distorted photographs at one scale to habitat maps of another scale, and to human drafting of the habitat maps. While there may be some errors in the data, extensive efforts have been made to make the habitat maps and areal measurements as accurate and clearly understood as possible.

APPENDICES

APPENDIX 1

The Louisiana Coastal Zone Boundary in the Chenier Plain Region

(as defined in State and Local Resources Management Act 361 of 1978, amended 1979 and 1980)

A. The west interstate boundary of the coastal zone shall be the boundary line between Louisiana and Texas as decreed by the Supreme Court of the United States in the case of "State of Texas vs. State of Louisiana on Bill of Complaint No. 36, Original, Decided May 16, 1977." Said westerly Louisiana boundary commences at the seaward limit of the Louisiana Submerged Lands Act Grant, which point is at Latitude 29° 35' 41" .917 North, Longitude 93° 48' 41" .845 West. Thence from said point on a line running north-northwesterly on a constant bearing of North 13° 44' 45" .8 West true, proceed to the seaward end of the Sabine River jetties, which point is at Latitude 29° 38' 37" .329 North, Longitude 93° 49' 30" .940 West. The interstate boundary from the seaward end of the jetties through Sabine Lake, Sabine Pass, and Middle Pass to the mouth of Sabine River is defined by a series of straight lines between points with locations described by either the Louisiana (Lambert) Plane Coordinate System (South Zone) or the Texas (Lambert) Plane Coordinate System (South Central Zone). The geographic positions of these same points are described in the above-mentioned Supreme Court decree and are shown on Exhibit 13, (see U.S. Department of Commerce [USDC] and Louisiana Department of Natural Resources [LDNR] 1980) which is in evidence therein. Thence proceed northerly along the Louisiana-Texas boundary, as described in the same decree and as shown on Texas Exhibits AAA-12 and AAA-13, which are in evidence therein, to the intersection with the westerly prolongation of the northerly right-of-way line of the GIWW, the intersection being situated at about Latitude 30° 03' 29" .99 North, Longitude 93° 41' 59" .15 West.

B. The seaward boundary of the coastal zone of Louisiana shall be the seaward limit of the State of Louisiana as determined by law.

C. The inland boundary of the coastal zone shall generally be a line beginning at the intersection of the northern line of the Intracoastal Canal and the Louisiana/Texas boundary, thence proceeding easterly along the northern bank of the Intracoastal Canal to Highway 82, thence easterly along Highway 82 to the intersection with the Hebert Canal.

D. The eastern boundary of the Chenier Plain (also the boundary between Hydrologic Units VII and VIII) follows Hebert Canal south from its intersection with Highway 82 to the Vermilion Lock structure on the Intracoastal Canal. Thence from said point, the boundary follows the north side of the Intracoastal Canal easterly until its junction with the Freshwater Bayou Canal, which it then follows along its western edge southwestward to the Gulf shoreline.

APPENDIX 2

DEFINITION OF THE TWO HYDROLOGIC UNITS IN THE CHENIER PLAIN REGION

Hydrologic Units VIII and IX correspond closely to those of Chabreck et al. 1968, but they have been refined to reflect more precisely the actual drainage basin divide. When habitat areas were measured and a hydrologic boundary fell in the middle of the habitat unit, as along the crest of a natural or artificial levee, the habitat unit was equally divided, with half the area assigned to each hydrologic unit. All hydrologic unit boundaries extend inland, or northward, as far as the habitats were delineated on each topographic map unit. A brief description of these units follows:

Hydrologic Unit VIII

Hydrologic Unit VIII includes most of the wetlands of Vermilion Parish and eastern Cameron Parish, Louisiana. The eastern boundary of Unit VIII starts at 30° 52' 30" N latitude and extends south approximately 1000 to 3000 ft (305 to 915 m) east of Coulee Baton Canal, to La. 82, east along La. 82 to Hebert Canal, south along the west bank of Hebert Canal to the GIWW, southeast along the north bank of the GIWW to the Freshwater Bayou Canal, southwest along the north bank of the Freshwater Bayou Canal to Schooner Bayou, west along the north bank of Schooner Bayou to Six Mile Canal, southwest along the west bank of Six Mile Canal-Belle Isle Canal to Freshwater Bayou, south along the west bank of Freshwater Bayou-Freshwater Canal to the Gulf of Mexico, then directly south to the 3 mi offshore boundary. The western boundary of Unit VIII begins at La. 27 at 30° 07' 30" N latitude and runs south along La. 27 to Oak Grove, then southeast along the west bank of Creole Canal to the Mermentau River, west along the north bank of the Mermentau River to the Gulf of Mexico, then directly south to the 3 mi offshore boundary.

Hydrologic Unit IX

Hydrologic Unit IX includes all of western Cameron Parish and the southern portion of Calcasieu Parish, Louisiana. The eastern boundary of Unit IX begins at La. 27 at

30° 07' 30" N latitude and runs south along La. 27 to Oak Grove, then southeast along the west bank of Creole Canal to the Mermentau River, west along the north bank of the Mermentau River to the Gulf of Mexico, then directly south to the 3 mi offshore boundary. The western boundary of Unit IX is the Louisiana-Texas State line from 30° 07' 30" N latitude, south to the 3 mi offshore boundary.

Appendix 3. List of USGS 7.5 Minute Topographic Map Names, CEI Numbers, Aerial Photographic Sources and Dates, and Stable Base Areas.

CEI #	TOPOGRAPHIC MAP NAME	PHOTO SOURCE	PHOTO DATE	STABLE BASE AREA (Acres)*	(Hectares)
175D	Orangefield, Texas-Louisiana	NASA	1978	41,272	16,715
176C	Orange, Louisiana-Texas	NASA	1978	41,272	16,715
176D	Cameron Farms, Louisiana	NASA	1978	41,272	16,715
177C	Black Lake, Louisiana	NASA	1978	41,272	16,715
177D	Moss Lake, Louisiana	NASA	1978	41,272	16,715
178C	Lake Charles SW, Louisiana	NASA	1978	41,272	16,715
178D	Lake Charles SE, Louisiana	NASA	1978	41,272	16,715
179C	Welsh SW, Louisiana	NASA	1978	41,272	16,715
179D	Welsh SE, Louisiana	NASA	1978	41,272	16,715
180C	Jennings SW, Louisiana	NASA	1978	41,272	16,715
209C	Intracoastal City, Louisiana	NASA	1978	41,369	16,754
210A	Forked Island NW, Louisiana	NASA	1978	41,317	16,733
210C	Forked Island SW, Louisiana	NASA	1978	41,369	16,754
210D	Forked Island SE, Louisiana	NASA	1978	41,369	16,754
211A	Grand Lake East NW, Louisiana	NASA	1978	41,317	16,733
211B	Grand Lake East NE, Louisiana	NASA	1978	41,317	16,733
211C	Grand Lake East SW, Louisiana	NASA	1978	41,369	16,754

211D	Grand Lake East SE, Louisiana	NASA	1978	41,369	16,754
212A	Lake Misere, Louisiana	NASA	1978	41,317	16,733
212B	Latania Lake, Louisiana	NASA	1978	41,317	16,733
212C	Grand Cheniere, Louisiana	NASA	1978	41,369	16,754
212D	Catfish Lake, Louisiana	NASA	1978	41,369	16,754
213A	Sweet Lake, Louisiana	NASA	1978	41,317	16,733
213B	Boudreaux Lake, Louisiana	NASA	1978	41,317	16,733
213C	Grand Bayou, Louisiana	NASA	1978	41,369	16,754
213D	Bayou Labauve, Louisiana	NASA	1978	41,369	16,754
214A	Browns Lake, Louisiana	NASA	1978	41,317	16,733
214B	Hackberry, Louisiana	NASA	1978	41,317	16,733
214C	Holly Beach, Louisiana	NASA	1978	41,369	16,754
214D	Cameron, Louisiana	NASA	1978	41,369	16,754
214E	Open Water	NASA	1978	41,422	16,776
214F	Open Water	NASA	1978	41,422	16,776
215A	Greens Bayou, Louisiana	NASA	1978	41,317	16,733
215B	Five Lakes, Louisiana	NASA	1978	41,317	16,733
215C	Johnsons Bayou, Louisiana	NASA	1978	41,369	16,754
215D	Peveto Beach, Louisiana	NASA	1978	41,369	16,754
216B	West of Greens Bayou, Texas-Louisiana	NASA	1978	41,317	16,733
216C	Port Arthur South, Texas-Louisiana	NASA	1978	41,369	16,754
216D	West of Johnsons Bayou, Louisiana-Texas	NASA	1978	41,369	16,754

219A	Sabine Pass, Texas-Louisiana	NASA	1978	41,422	16,776
219B	Texas Point, Texas-Louisiana	NASA	1978	41,422	16,776
219D	Open Water	NASA	1978	41,472	16,796
220A	South of Johnsons Bayou, Louisiana	NASA	1978	41,422	16,776
220B	Open Water	NASA	1978	41,422	16,776
221A	Open Water	NASA	1978	41,422	16,776
221B	South of Bayou LaBauve, Louisiana	NASA	1978	41,422	16,776
222A	Hog Bayou NW, Louisiana	NASA	1978	41,422	16,776
222B	Hog Bayou NE, Louisiana	NASA	1978	41,422	16,776
222C	Open Water	NASA	1978	41,472	16,796
222D	South of Hog Bayou NE, Louisiana	NASA	1978	41,472	16,796
223A	Constance Bayou NW, Louisiana	NASA	1978	41,422	16,776
223B	Constance Bayou NE, Louisiana	NASA	1978	41,422	16,776
223C	Constance Bayou SW, Louisiana	NASA	1978	41,472	16,796
223D	Constance Bayou SE, Louisiana	NASA	1978	41,472	16,796
224A	Pecan Island NW, Louisiana	NASA	1978	41,422	16,776
224B	Pecan Island NE, Louisiana	NASA	1978	41,422	16,776
224C	Pecan Island SW, Louisiana	NASA	1978	41,472	16,796
224D	Pecan Island SE, Louisiana	NASA	1978	41,472	16,796
224E	Open Water	NASA	1978	41,524	16,804
224F	Open Water	NASA	1978	41,524	16,804
225A	Cheniere au Tigre NW, Louisiana	NASA	1978	41,422	16,776

* acres x .405 = hectares.

APPENDIX 4

HIERARCHICAL STRUCTURE OF HABITAT CLASSIFICATION SYSTEM USED IN MAPPING THE CHENIER PLAIN REGION

HABITAT MAP SYMBOLS

SYSTEM AND SUBSYSTEM

*SYSTEM
*subsystem

M MARINE
1 subtidal
2 intertidal
E ESTUARINE
1 subtidal
2 intertidal
P PALUSTRINE
— no subsystem
R RIVERINE
1 tidal
2 lower perennial
3 upper perennial
4 intermittent
L LACUSTRINE
1 limnetic
2 littoral
U UPLAND
— no subsystem

CLASS AND SUBCLASS

*CLASS
*subclass

AB AQUATIC BED
1 submergent algal
2 submergent vascular
3 submergent moss
4 floating-leaved
5 floating
6 unknown submergent
7 unknown surface
BB BEACH/BAR
1 cobble/gravel
2 sand/shell
EM EMERGENT
1 persistent
2 nonpersistent
3 narrow-leaved nonpersistent
4 broad-leaved nonpersistent
5 narrow-leaved persistent
6 broad-leaved persistent
FL FLAT
1 cobble/gravel
2 sand/shell
3 mud
4 organic
5 vegetated pioneer
6 vegetated non-pioneer
FO FORESTED
1 broad-leaved deciduous
2 needle-leaved deciduous
3 broad-leaved evergreen
4 needle-leaved evergreen
5 dead
6 deciduous
7 evergreen
OW OPEN WATER
unknown bottom
RF REEF
1 coral
2 mollusc
3 worm
RS ROCKY SHORE
1 bedrock
2 boulder
3 vegetated non-pioneer
SB STREAM BED
1 cobble/gravel
2 sand
3 mud
4 organic
SS SCRUB/SHRUB
1 broad-leaved deciduous
2 needle-leaved deciduous
3 broad-leaved evergreen
4 needle-leaved evergreen
5 dead
6 deciduous
7 evergreen
UB UNCONSOLIDATED BOTTOM
1 cobble/gravel
2 sand
3 mud
4 organic
DV DEVELOPED
1 urban/residential/commercial/industrial
2 agriculture/pasture/modified grasslands
3 unvegetated land/spoil/disposal sites
GR GRASSLANDS

WATER REGIME MODIFIERS

NONTIDAL
A temporary
B saturated
C seasonal
D seasonal/well-drained
E seasonal/saturated
F semipermanent
G intermittently exposed
H permanent
J intermittently flooded

NONTIDAL COMBINED
Z intermittently exposed/permanent (G, H above)
W intermittently flooded/temporary (J, A above)
Y saturated semipermanent all seasonals (B, C, D, E, F above)

TIDAL
L subtidal
M irregularly exposed
N regular
P irregular
R seasonal
S temporary
T semipermanent
V permanent

NONTIDAL AND TIDAL
U unknown
K artificial

WATER CHEMISTRY MODIFIERS

COASTAL HALINITY MODIFIER
1 hyperhaline
2 euhaline
3 mixohaline (brackish)
4 polyhaline
5 mesohaline
6 oligohaline
— fresh

INLAND SALINITY MODIFIER
7 hypersaline
8 eusaline
9 mixosaline
— fresh

pH FRESH WATER MODIFIER
a acid
t circumneutral
i alkaline

OTHER MODIFIERS

SPECIAL MODIFIERS
b beaver
d partially drained/ditched
f farmed
e reclaimed wetland
h diked/impounded
r artificial
s spoil
x excavated
o oil/gas/mineral
1 tidal
p beach
w leveed; standing water
m leveed; managed water levels

SOIL MODIFIERS
g organic
n mineral

APPENDIX 5

GLOSSARY OF HABITAT LABELS

ESTUARINE

E1OW: Estuarine Subtidal Open Water

A nonchannelized embayment, pond, lake, etc., having salinities which can fluctuate greatly in response to the freshwater inputs or high evaporation rates. Generally, the salinity is more than 0.5 ppt and less than 30 ppt. Because of the large discharges of freshwater into the coastal and nearshore regions of the Mississippi Deltaic Plain Region, all offshore waters except those south and east of the Mississippi barrier and Louisiana Chandeleur Islands are labeled estuarine. Water bodies located in nonfresh marshes are also labeled estuarine.

E1OWh: Estuarine Subtidal Open Water Impounded/Diked

An artifically leveed and impounded body of water having a salinity above 0.5 ppt. Abandoned reclamation sites that have become flooded are also labeled as being artificially impounded in order to distinguish them from natural water bodies.

E1OWo: Estuarine Subtidal Open Water Oil/Gas/Minerals

An excavated or impounded estuarine water body constructed and utilized by oil-, gas-, or sulphur-related industries (e.g., brine discharge pits, rig cuts, pipeline canals).

E1OWt: Estuarine Subtidal Open Water Tidal

A naturally channelized body of water having a salinity of 0.5 ppt or greater during the period of average annual low flow; a tidal channel or abandoned distributary channel.

E1OWx: Estuarine Subtidal Open Water Excavated

An excavated estuarine water body (e.g., lake, pond, borrow pit, canal, marina) constructed and utilized for purposes other than oil and gas activities.

E2EM5N4: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Regular Tidal Regime** Polyhaline

A saline marsh commonly containing the narrow-leaved persistent species oystergrass (Spartina alterniflora), blackrush (Juncus roemerianus), batis (Batis maritima), and saltgrass (Distichlis spicata) (Chabreck and Linscombe 1978).

E2EM5N4d: **Estuarine Intertidal Emergent Narrow-leaved Pesistent Vegetation Regular Tidal Regime Polyhaline Partially Drained/Ditched**

A saline marsh that has been ditched and partially drained or is in the process of being drained, but which still supports saline marsh vegetaion.

E2EM5N4s: **Estuarine Intertidal Emergent Narrow-leaved Persistent Vegetation Regular Tidal Regime Polyhaline Spoil**

A saline marsh that has developed on spoil deposited in an estuarine water body.

E2EM5P5: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Mesohaline**

A brackish marsh commonly containing the narrow-leaved persistent species wiregrass (Spartina patens), three-cornered grass (Scirpus olneyi), and coco (Scirpus robustus) (Chabreck and Linscombe 1978).

E2EM5P5d: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Mesohaline Partially Drained/Ditched**

A brackish marsh that has been ditched and partially drained, or is in the process of being drained but still supports the wetland flora.

E2EM5P5m: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Mesohaline Leveed; Managed Water Levels**

Brackish marshes that are designated on maps as being under State or Federal control where the areas have been diked and water levels are managed to enhance wildlife resources.

E2EM5P5w: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Mesohaline Leveed; Standing Water**

Brackish marshes that have been leveed but where water levels are not controlled. Such marshlands are characterized by broken marsh and extensive standing water areas.

E2EM5P6: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Oligohaline**

An intermediate marsh that commonly contains bulltongue (Sagittaria sp.), sawgrass (Cladium jamaicense), roseau cane (Phragmites australis), bullwhip (Scirpus californicus), and wild millet (Echinochloa walteri) (Chabreck and Linscombe 1978).

E2EM5P6d: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Oligohaline Partially Drained/Ditched**

An intermediate marsh that has been ditched and partially drained or is in the process of being drained but still supports wetland flora.

E2EM5P6m: **Estuarine Intertidal Emergent Vegetation Narow-leaved Persistent Irregular Tidal Regime Oligohaline Leveed; Managed Water Levels**

Intermediate marshlands that are designated on maps as being under State or Federal control where the wetlands have been diked and water levels are managed to enhance wildlife resources.

E2EM5P6w: **Estuarine Intertidal Emergent Vegetation Narrow-leaved Persistent Irregular Tidal Regime Oligohaline Leveed; Standing Water**

Intermediate marshlands that are leveed but where water levels are not controlled. Such areas are characterized by broken marsh and extensive standing water areas.

E1AB: **Estuarine Subtidal Aquatic Bed**

A submerged aquatic bed of unknown species composition in an estuarine water body.

E1AB2: **Estuarine Subtidal Aquatic Bed Submergent Vascular Vegetation**

Submerged vascular vegetation in an estuarine water body. The location of these beds was obtained from Montz (1979, ongoing research).

E1AB5: **Estuarine Subtidal Aquatic Bed Floating**

Floating aquatic mats, usually water hyacinths (Eichhornia crassipes), that have been flushed out of freshwater environments into low-salinity estuarine water bodies. They can persist for a short period of time until increased salinities kill them.

E1AB5h: Estuarine Subtidal Aquatic Bed Floating Diked/Impounded

An artificially leveed and impounded body of water having a salinity above 0.5 ppt during low water stages and covered by a floating aquatic mat, such as water hyacinths.

E1AB5o: Estuarine Subtidal Aquatic Bed Floating Oil/Gas/Mineral

An excavated or impounded estuarine water body, constructed and utilized by petroleum or other mineral industries, which contains floating aquatic mats, such as water hyacinths.

E1AB5x: Estuarine Subtidal Aquatic Bed Floating Excavated

An excavated estuarine water body, constructed and utilized for purposes other than petroleum or mineral industries, which is covered by a floating aquatic mat, such as water hyacinths.

E2FL3: Estuarine Intertidal Flat Mud

Unvegetated mud deposits in estuarine areas with low wave and tidal energy regimes. These are common in protected, broken marsh environments and on the perimeter of the Lower Mississippi River Delta.

E2FL3h: Estuarine Intertidal Flat Mud Diked/Impounded

Unvegetated deposits of mud within diked, estuarine areas that are exposed during low water stages. Such areas are common on abandoned reclamation sites.

E2FL3/4: Estuarine Intertidal Flat Mud/Organic

Unvegetated organic and mud deposits in estuarine areas with low wave and tidal energy regimes. They are commonly found in broken marsh areas subject to shallow-water flooding, such as the perimeter of the Lower Mississippi River Delta and the deteriorating former fresh and intermediate marsh areas experiencing increased salinities.

E2FL5: Estuarine Intertidal Flat Vegetated Pioneer

Commonly, newly deposited sediments in areas subject to regular flooding by estuarine water that are being vegetated by pioneer plants, such as very young willows or grasses. Such habitats are numerous in the newly emergent Atchafalaya River Delta in Atchafalaya Bay.

E2UB3/4: Estuarine Intertidal Unconsolidated Bottom Mud/Organic

Wave-cut terraces in unvegetated, organic, and mud deposits along eroding estuarine marsh shorelines.

E2BB2 Estuarine Intertidal Beach Sand/Shell

Wave reworked sand and/or shell material along a land-water interface in an estuarine environment.

E2RF2: Estuarine Intertidal Reef Mollusc

Irregularly shaped deposits of living and/or dead oysters in estuarine environments. The greatest concentration of reefs occurs south of Marsh Island, in Southwest Pass (Vermilion Parish), and west of Point au Fer, Louisiana.

E2RS2r: Estuarine Intertidal Rocky Shore Boulder Artificial

Man-made deposits of boulders used in the construction of riprap bulkheads and jetties.

LACUSTRINE

L2OW: Lacustrine Littoral Open Water

A large, shallow body of freshwater with an area greater than 8 ha (20 ac) and a depth less than 6 ft. Virtually all lakes in the Mississippi Deltaic Plain Region are shallow and appear on USGS topographic maps as being less than 6 ft deep. Their shallowness is also documented in Barrett (1970).

L2OWh: Lacustrine Littoral Open Water Diked/Impounded

A large, shallow body of freshwater that has been artificially impounded by means of damming or diking. Large, abandoned and flooded reclamation sites in freshwater areas of coastal Louisiana were labeled as impounded to indicate their artificial, rather than natural, origin.

L2OWo: Lacustrine Littoral Open Water Oil/Gas/Mineral

A large, shallow body of freshwater that was constructed either by impoundment or excavation for use in the oil, gas, sulphur, or other mineral industries.

L2OWx: Lacustrine Littoral Open Water Excavated

A large, shallow body of freshwater that was created by artificial excavation. These are most commonly irregularly shaped borrow pits in coastal Louisiana.

L2AB: Lacustrine Littoral Aquatic Bed

Mats of aquatic vegetation in large, shallow bodies of freshwater. This label is used where it is not possible to distinguish among vegetated flats, submerged, or floating aquatics. This habitat type is most common in formerly fresh environments experiencing saltwater intrusion.

L2AB5: Lacustrine Littoral Aquatic Bed Floating

Floating aquatic mats, usually water hyacinths or duckweed (Lemna spp.), present on large, shallow bodies of freshwater. Their location frequently shifts in relation to wind direction and flooding currents, and in winter these mats die and sink below the surface.

L2AB5h: Lacustrine Littoral Aquatic Bed Floating Diked/Impounded

A large, shallow body of freshwater that has been artificially impounded by means of damming or diking and which supports a floating aquatic mat, such as water hyacinths.

L2FL3: Lacustrine Littoral Flat Mud

Expanses of unvegetated mud deposits along the shore or in shallow portions of large freshwater lakes.

L2FL3/4: Lacustrine Littoral Flat Mud/Organic

Expanses of unvegetated mud and organic deposits along the shore or in shallow portions of large freshwater lakes.

L2FL5: Lacustrine Littoral Flat Vegetated Pioneer

Sediment deposits, within or along the shore of large, shallow freshwater bodies, that are being vegetated by pioneer species.

PALUSTRINE

PDV: Palustrine Developed

A cleared, regularly maintained, and usually linear right-of-way through a wetland forest or scrub/shrub habitat. These areas usually contain

emergents, aquatic beds, or early successional stages of the climax habitat that has been removed.

POW: Palustrine Open Water

A nonchannelized, naturally occurring body of freshwater less than 8 ha (20 ac) in area; a pond.

POWh: Palustrine Open Water Diked/Impounded

An artificially impounded, nonchannelized body of freshwater less than 8 ha (20 ac) in area. This includes dammed farm ponds and small reservoirs. In coastal Louisiana, diked but abandoned and flooded reclamation sites in freshwater areas are also labeled POWh.

POWo: Palustrine Open Water Oil/Gas/Mineral

A small body of freshwater, less than 8 ha (20 ac) in area, that was constructed either by impoundment or excavation for use by the oil, gas, sulphur, or other mineral industries.

POWx: Palustrine Open Water Excavated

An artificially excavated, nonchannelized body of freshwater less than 8 ha (20 ac) in area, including farm ponds, borrow pits, and ponds left from mining operations.

PAB5: Palustrine Aquatic Bed Floating

A floating aquatic mat, frequently water hyacinths or duckweed, in a small, freshwater body.

PAB5h: Palustrine Aquatic Bed Floating Diked/Impounded

An artificially impounded, nonchannelized body of freshwater less than 8 ha (20 ac) in area covered by a floating aquatic mat, such as water hyacinths.

PFL3: Palustrine Flat Mud

A deposit composed of mud-sized particles located in or along the shore of a small body of freshwater.

PFL5: Palustrine Flat Vegetated Pioneer

A sediment deposit in or along the shore of a small body of freshwater that is being vegetated by pioneer species, such as young willows or grasses.

PEM: Palustrine Emergent Vegetation

A freshwater marsh dominated by such species as maidencane (Panicum hemitomon), pennywort (Hydrocotyle sp.), pickerelweed (Pontederia cordata), alligatorweed (Alternanthera philoxeroides), and bulltongue (Chabreck and Linscombe 1978). Because the coastal marshes contain a mixture of broad-leaved and narrow-leaved persistent vegetation, no subclass was assigned to this marsh type on the habitat maps.

PEMd: Palustrine Emergent Vegetation Partially Drained/Ditched

A former freshwater marsh that has been ditched and partially drained or is in the process of being drained but which still supports wetland flora.

PEMm: Palustrine Emergent Vegetation Leveed; Managed Water Levels

Areas that are designated on maps as being under State or Federal supervision where the wetlands, containing freshwater marsh species, have been diked and water levels are managed to enhance wildlife resources.

PSS1: Palustrine Scrub/Shrub Broad-leaved Deciduous

A freshwater wetland dominated by broad-leaved deciduous scrubs and shrubs. Habitats commonly include pioneering willows (Salix sp.) and cottonwoods (Populus deltoides) on recently accreted battures and in partially drained freshwater marshes. Marshes being invaded by eastern baccharis (Baccharis halimifolia), hackberry (Celtis laevigata), buttonbush (Cephalanthus occidentalis), and palmetto (Sabal minor) are also labeled PSS1. No attempt was made to distinguish between naturally occurring scrub/shrub wetlands and reclaimed wetlands being pioneered by shrubs.

PSS1/2: Palustrine Scrub/Shrub Broad-leaved Deciduous/Needle-leaved Deciduous

The freshwater wetlands dominated by broad-leaved and needle-leaved deciduous scrubs and shrubs. This includes shrubs as well as saplings (young trees less than 6 m [20 ft] high). This particular classification is most common in the Lower Mississippi River Delta where young willows and cypress less than 6 m (20 ft) high are pioneer species on newly accreted lands. PSS1/2 also includes some partially drained wetlands. Because of the difficulty in distinguishing between naturally occurring

and partially drained wetlands with shrubs, no distinction was made between the two habitat types of different origin but similar species composition.

PSS1/3: Palustrine Scrub/Shrub Broad-leaved Deciduous/Broad-leaved Evergreen

A freshwater wetland dominated by broad-leaved deciduous and broad-leaved evergreen scrubs and shrubs. These can be both natural and partially drained wetlands. Common species include eastern baccharis, young willows, wax myrtle (Myrica cerifera), and palmetto. No attempt was made to discern the difference between natural and drained wetlands containing shrubs.

PSS2 Palustrine Scrub/Shrub Needle-leaved Deciduous

A freshwater wetland dominated by needle-leaved deciduous scrub/shrub vegetation (i.e., baldcypress).

PFO1/2: Palustrine Forested Broad-leaved Deciduous/Needle-leaved Deciduous

A deep-water swamp containing mostly broad-leaved deciduous and needle-leaved deciduous trees. Most areas so labeled on the habitat maps contain cypress (Taxodium distichum) and tupelogum (Nyssa sylvatica, N. aquatica). Swamps in the interdistributary basins of the Mississippi and Pearl Rivers are dominated by these species. Aquatic beds and emergents may characterize the understory.

PFO1/3: Palustrine Forested Broad-leaved Deciduous/Broad-leaved Evergreen

Wetland forests dominated by broad-leaved deciduous and broad-leaved evergreen trees. These areas, while below 5 ft in elevation, are better drained than backswamps and are commonly found on subsiding natural levees and between wetter bottomland hardwoods and drier mixed levee and upland forests. Common species in such environments include live oak (Quercus virginiana), sweetgum (Liquidambar styraciflua), magnolia (Magnolia sp.), and hackberry.

PFO1/2/3: Palustrine Forested Broad-leaved Deciduous/Needle-leaved Deciduous/ Broad-leaved Evergreen

A wetland forest containing a mixture of broad-leaved and needle-leaved deciduous and broad-leaved evergreen trees. Frequently such bottom land hardwood forests are transition zones between the deep-water backswamp and the better-drained mixed levee and upland hardwoods. Common species in these forests are cypress, tupelo-gum, red maple (Acer rubrum), green ash (Fraxinus pennsylvanica var. lanceolata), and live oak.

RIVERINE

R1OW: Riverine Subtidal Open Water

Freshwater contained within a natural channel which is influenced by tidal action.

R1OWo: Riverine Subtidal Open Water Oil/Gas/Mineral

Freshwater contained within an excavated channel which is influenced by tidal action. Such canals are constructed and utilized by oil-, gas-, sulphur-, and other mineral-related industries to convey the pipelines or drilling equipment.

R1OWx: Riverine Subtidal Open Water Excavated

Freshwater contained within an excavated channel which is influenced by tidal action. These channels are often used for navigation or drainage.

R2OW: Riverine Lower Perennial Open Water

Permanent, nontidal freshwater contained within a natural channel.

R2OWo: Riverine Lower Perennial Open Water Oil/Gas/Mineral

Permanent, nontidal freshwater contained within an excavated channel. Such canals are constructed and utilized by oil-, gas-, sulphur-, and other mineral-related industries to convey the pipelines and drilling equipment.

R2OWx: Riverine Lower Perennial Open Water Excavated

Permanent, nontidal freshwater contained within an excavated channel. These channels are used for navigation or drainage.

R4OWx: Riverine Intermittent Open Water Excavated

Infrequently flowing freshwater contained within an excavated channel. These are usually channelized natural waterways or drainage canals, most of which are located on the Pleistocene Terrace or on or near the levee crests.

R1AB Riverine Tidal Aquatic Bed

Mats of aquatic vegetation of undetermined species composition located within a permanent, nontidal freshwater channel.

R1AB5: Riverine Tidal Aquatic Bed Floating

A floating aquatic bed, usually water hyacinth or duckweed, in tidally influenced freshwater contained within a natural channel.

R1AB5o: Riverine Tidal Aquatic Bed Vegetation Oil/Gas/Mineral

A floating aquatic bed, usually water hyacinth or duckweed, in tidally influenced freshwater contained within a channel excavated by the mineral industry.

R1AB5x: Riverine Tidal Aquatic Bed Floating Excavated

A floating aquatic bed, usually water hyacinth or duckweed, in tidally influenced freshwater contained within an excavated channel.

R2AB5o: Riverine Lower Perennial Aquatic Bed Floating Oil/Gas/Mineral

A floating aquatic bed, usually water hyacinth or duckweed, in permanent, nontidal freshwater contained within a channel excavated by the mineral industry.

UPLAND

UDV: Upland Developed

A relatively narrow, cleared, regularly maintained, usually linear right-of-way through an upland forested or scrub/shrub habitat. Such areas are vegetated, but frequent maintenance prohibits establishment of climax vegetation.

UDV1 Upland Developed Urban/Residential/Commercial/Industrial

Residential, commercial, urban, and industrial developments on an upland site or in areas protected from flooding by levees and drainage canals.

UDV1o: Upland Developed Commerical/Industrial Oil/Gas/Mineral

Industrial development associated with the mineral industry. This habitat type includes drilling complexes onshore and some refining sites.

UDV2: Upland Developed Agriculture/Pasture/Modified Grasslands

Nonwetland areas being cultivated for crops, maintained as pasture, or left as grasslands. Some of the grasslands may be seasonally wet. While

some cultivated sites may be subject to seasonal flooding, they are not considered wetland habitats because nonwetland species composition is maintained through management.

UDV2e: **Upland Developed Agriculture/Pasture/Modified Grasslands Reclaimed Wetland**

Louisiana has areas of former wet grasslands that have been diked, ditched, drained, and put into cultivation, pasture, or nonwet grasslands. Usually pumping and active management must be maintained to prevent such areas from converting to wetlands. Reclaimed bottomland hardwoods and swamps are not designated as UDV2e.

UDV3: **Upland Developed Unvegetated Land/Spoil/Disposal Sites**

Regardless of elevation, areas that have been altered and cleared of vegetation through disposal of spoil or nonliquid waste materials or cleared for various reasons, including mining, are labeled UDV3. Natural plant succession on such sites is often interrupted because of constant disturbance. Some low-lying, reworked, unvegetated shell middens in the marsh may also be labeled UDV3.

USS1: **Upland Scrub/Shrub Broad-leaved Deciduous**

Well-drained, formerly cleared uplands or recently drained wetlands that have been invaded by broad-leaved deciduous scrubs and shrubs. On naturally occuring upland sites, these are mixed hardwoods, while in former wetlands, willow, hackberry, and Chinese tallow are the more common invaders.

USS1s: **Upland Scrub/Shrub Broad-leaved Deciduous Spoil**

Spoil deposits of varying elevation that are better-drained than the surrounding wetlands and which commonly support young willows and shrubs, such as iva (Iva frutescens) and eastern baccharis. Often the more recently vegetated spoil deposits are labeled USS1s and the more mature deposits that have remained elevated are labeled USS1/3s to indicate their greater species diversity, especially the invasion of broad-leaved evergreen species, such as wax myrtle.

USS1/3: **Upland Scrub/Shrub Broad-leaved Deciduous/Broad-leaved Evergreen**

Well-drained, formerly cleared upland or recently drained wetlands that have been invaded by broad-leaved deciduous and broad-leaved evergreen species. On natural uplands, these are mixed hardwoods, including live oak and wax myrtle. On drained wetlands, the more common invaders are willow, hackberry, Chinese tallow (Sapium sebiferum), and wax myrtle.

USS1/3s: Upland Scrub/Shrub Broad-leaved Deciduous/Broad-leaved Evergreen Spoil

Spoil deposits of varying elevation that are better-drained than the surrounding wetlands and which commonly support young willows, iva, baccharis, wax myrtle, and sometimes yaupon (Ilex vomitoria). Usually such spoil deposits in saline environments have a variety of shrubs, herbs, and grasses.

USS1/3/4: Upland Scrub/Shrub Broad-leaved Deciduous/Broad-leaved Evergreen/ Needle-leaved Evergreen

Elevated, better-drained sites on natural levees and terraces that support broad-leaved deciduous, broad-leaved evergreen and needle-leaved evergreen shrubs. This habitat is commonly associated with old field succession and along roads and fences.

UFO1s: Upland Forested Broad-leaved Deciduous Spoil

All spoil deposits of varying elevation which are vegetated by broad-leaved deciduous trees. Willow, Chinese tallow, and hackberry are common species on such better-drained, man-made sites. Upland, mixed levee hardwoods can be the climax species on spoil deposits that remain elevated (Monte 1978).

UFO1/3: Upland Forested Broad-leaved Deciduous/Broad-leaved Evergreen

Elevated, better-drained sites on natural levees and terraces that support broad-leaved deciduous and broad-leaved evergreen trees. On USGS topographic maps, such sites are shown to be above 5 ft in elevation and are colored green but without a swamp pattern. The common species of mixed hardwoods are oaks, pecans (Carya spp.) and hickories (Carya spp.). This category may include some temporarily flooded wetlands.

UFO1/3/4: Upland Forested Broad-leaved Deciduous/Broad-leaved Evergreen/ Needle-leaved Evergreen

Well-drained upland sites on the Pleistocene Terrace which are vegetated by a mixture of broad-leaved deciduous, broad-leaved evergreen, and needle-leaved evergreen trees (e.g., mixed upland hardwoods and pines).

UFO3: Upland Forested Broad-leaved Evergreen

Well-drained upland sites, usually above 5 ft in elevation on USGS topographic maps, which support broad-leaved evergreen trees. Such areas are often dominated by live oak and include cheniers (abandoned beach ridges) and Indian middens.

UGRp: Upland Grasslands Beach Dunes

Vegetated beach dunes above 5 ft in elevation, located primarily on the barrier islands.

APPENDIX 6

VEGETATION ASSOCIATIONS BY PHYSIOGRAPHIC FORM/UNIT IN THE CHENIER PLAIN REGION

Appendix 6A. Marsh Species Recorded in 1968.

PLANT SPECIES BY MARSH TYPE	% OF PLANT SPECIES HYDROLOGIC UNIT VIII	HYDROLOGIC UNIT IX
FRESH MARSH		
Sensitive joint vetch (Aeschynomene virginica)	1.71	--
Alligatorweed (Alternanthera philoxeroides)	9.46	25.87
Carolina bacopa (Bacopa caroliniana)	1.14	--
Waterhyssop (Bacopa monnieri)	--	2.99
Watershield (Brasenia schreberi)	1.71	--
Fanwort (Cabomba caroliniana)	1.01	--
Bermuda grass (Cynodon dactylon)	--	2.99
Rattlebox (Daubentonia texana)	--	1.29
Saltgrass (Distichlis spicata)	--	1.99
Walter's millet (Echinochloa walteri)	--	2.19
Spikerush (Eleocharis sp.)	5.60	8.46
Softrush (Juncus effusus)	--	1.99
Willow primrose (Jussiaea sp.)	1.79	--
American lotus (Nelumbo lutea)	1.32	--
White waterlily (Nymphaea odorata)	2.41	1.99
Maidencane (Panicum hemitomon)	21.50	1.99
Paspalum (Paspalum dissectum)	1.40	--
Paspalum (Paspalum vaginatum)	--	5.77
Slender pondweed (Potamogeton pusillus)	1.01	--
Bulltongue (Sagittaria falcata)	28.00	22.88
Bullwhip (Scirpus californicus)	--	4.98
Wiregrass (Spartina patens)	8.09	7.96

Horned Bladderwort (Utricularia cornuta)	3.42	3.98
Other Species	10.43	2.68

INTERMEDIATE MARSH

Belle-dame (Acnida alabamensis)	--	1.21
Alligatorweed (Alternanthera philoxeroides)	8.31	2.24
Carolina bacopa (Bacopa caroliniana)	1.28	--
Waterhyssop (Bacopa monnieri)	4.05	2.49
Roundleaf bacopa (Bacopa rotundifolia)	1.70	--
Cyperus (Cyperus odoratus)	6.17	--
Walter's millet (Echinochloa walteri)	5.54	--
Spangletop (Leptochloa fascicularis)	2.98	3.00
Paspalum (Paspalum vaginatum)	6.39	13.29
Roseau cane (Phragmites communis)	5.96	3.97
Camphorweed (Pluchea camphorata)	2.47	--
Bulltongue (Sagittaria falcata)	2.55	4.59
Freshwater three-square (Scirpus americanus)	4.68	--
Bullwhip (Scirpus californicus)	--	6.73
Three-cornered grass (Scirpus olneyi)	--	6.21
Leafy three-square (Scirpus robustus)	--	1.21
Bequilla (Sesbania exaltata)	--	2.07
Marsh purslane (Sesuvium portulacastrum)	2.98	--
Wiregrass (Spartina patens)	36.84	46.83
Gulf cordgrass (Spartina spartineae)	1.28	1.73
Deer pea (Vigna repens)	1.49	--
Other Species	5.33	4.43

BRACKISH MARSH

Waterhyssop (Bacopa monnieri)	--	5.33
Saltgrass (Distichlis spicata)	27.87	8.96
Walter's millet (Echinochloa walteri)	2.08	--
Dwarf spikerush (Eleocharis parvula)	1.61	--
Saltmarsh gerardia (Gerardia maritima)	1.38	--
Paspalum (Paspalum vaginatum)	1.84	7.22
Widgeongrass (Ruppia maritima)	--	1.18
Three-cornered grass (Scirpus olneyi)	--	6.99
Leafy three-square (Scirpus robustus)	4.19	2.49
Yellow foxtais (Setaria glauca)	--	1.38
Hog cane (Spartina cynosuroides)	2.08	--
Wiregrass (Spartina patens)	53.80	59.81
Gulf cordgrass (Spartina spartineae)	--	1.58
Other Species	5.15	5.06

SALINE MARSH

Batis (Batis maritima)	--	20.24
Sea-oxeye (Borrichia frutescens)	4.69	--
Saltgrass (Distichlis spicata)	68.75	54.66
Salt matrimony vine (Lycium carolinianum)	1.56	--
Glasswort (Salicornia bigelovii)	1.56	--
Leafy three-square (Scirpus robustus)	6.25	--
Oystergrass (Spartina alterniflora)	10.94	24.29
Wiregrass (Spartina patens)	6.25	--
Other Species	--	0.81

Source: Chabreck 1972.

Appendix 6B. Major Marsh Species Noted in the Late 1940s.

FRESH MARSH (Fresh)

Common Name	Scientific Name
Canouche	Panicum hemitomon
Cattail	Typha spp.
Bulltongue	Sagittaria spp.
Spikerush	Eleocharis quadrangulata, E. palustris, E. cellulosa
Yellow cutgrass	Zizaniopsis miliacea
Sawgrass	Cladium jamaicense
Roseau cane	Phragmites communis
Bulrush	Scirpus californicus, S. validus

FLOATING FRESH MARSH (Fresh)

Canouche	Panicum hemitomon

EXCESSIVELY DRAINED FRESH MARSH (Nonfresh)

Blackrush	Juncus roemerianus
Wiregrass	Spartina patens
Oystergrass	Spartina alterniflora
Sawgrass	Cladium jamaicense

BRACKISH THREE-CORNERED GRASS MARSH (Nonfresh)

Three-cornered grass	Scirpus olneyi
Wiregrass	Spartina patens

INTERMEDIATE MARSH (Nonfresh)

Sawgrass	Cladium jamaicense
Roseau cane	Phragmites communis
Cattail	Typha spp.
Bulrush	Scirpus californicus, S. validus

LEAFY THREE-CORNERED GRASS OR COCO MARSH (Nonfresh)

Coco	Scirpus robustus
Wiregrass	Spartina patens
Hogcane	Spartina cynosuroides

SAWGRASS MARSH (Fresh)

Sawgrass	Cladium jamaicense
Cattail	Typha spp.
Bulrush	Scirpus californicus, S. validus
Roseau cane	Phragmites communis
Bull-tongue	Sagittaria spp.
Hogcane	Spartina cynosuroides
Spikerush	Eleocharis quadrangulata, E. palustris, E. cellolusa
Yellow cutgrass	Zizaniopsis miliacea

SEA RIM (Nonfresh)

Sand and Shell Deposits

Source: O'Neil 1949.

Appendix 6C. Major Species Noted on Upland Sites.

1. PRAIRIE TERRACE

A. Better Drained

Agricultural crops, such as rice and soybeans

Pasture

Prairie grasslands

B. Poorly Drained Depressions (Brown 1945)

(Common Name)	(Scientific Name)
Red maple	Acer rubrum
Green ash	Fraxinus pennsylvanica var. lanceolata
Water oak	Quercus nigra
Winged elm	Ulmus alata
Red gum	Liquidambar styraciflua
Willow oak	Quercus phellos
Swamp black gum	Nyssa sylvatica
Bald cypress	Taxodium distichum

C. Along Streams and on Ridges (Brown 1945)

Water elm	Planera aquatica
Cherrybark oak	Quercus pagoda
Loblolly pine	Pinus taeda
Post oak	Quercus stellata
Green ash	Fraxinus pennsylvanica var. lancelota
American elm	Ulmus americana
Red gum	Liquidambar styraciflua
Shagbark hickory	Carya ovata
Cow oak	Quercus prinus
Hawthorn	Crataegus sp.

D. On Pimple Mounds and Sandy Ridges (Brown 1945)

Longleaf pine	Pinus palustris
Live oak	Quercus virginiana
Black gum	Nyssa sylvatica

2. CHENIERS

A. Abandoned Beach Ridges (Palmisano 1967, 1970)

Overstory

Live oak	Quercus virginiana
Hackberry	Celtis laevigata
American elm	Ulmus americana
Swamp maple	Acer rubrum var. drummondii
Cypress	Taxodium distichum
Water locust	Gleditsia aquatica
Tooth-ache tree	Zanthoxylum clava-herculis
Persimmon	Diospyros virginiana
Water oak	Quercus nigra

Understory

Palmetto	Sabal minor
Blackberry	Rubus spp.
Buttonbush	Cephalanthus occidentalis
Deciduous holly	Ilex decidua
Chickasaw plum	Prunus angustifolia
Groundsel tree	Iva frutescens
Saltmeadow cordgrass	Spartina patens
Grape	Vitus spp.
Black willow	Salix nigra
Salt cedar	Tamarix gallica
Prickly pear cactus	Opuntia sp.

3. NATURAL LEVEES AND SPOIL BANKS

A. Low-Lying in Marshes (Brown 1945)

Live oak	Quercus virginiana
Tooth-ache tree	Zanthoxylum clava-herculis
Hackberry	Celtis laevigata
Hawthorn	Cratagus sp.
Opopanax	Acacia farnesiana
Marsh elder	Iva frutescens
Eastern baccharis	Baccharis halimifolia

B. Low-Lying Spoil: Superior Canal, Cameron Parish (Spindler and Noble 1974)

Wiregrass	Spartina patens
Eastern baccharis	Baccharis halimifolia
Roseau cane	Phragmites communis
Boneset	Eupatorium serotinum
Hairypod cowpea	Vigna luteola
Pink hybiscus	Kosteletskya virginica
Leafy three-square	Scirpus robustus
Rouge plant	Rivina humilis
Pokeweed	Phytolacca americana
Morningglory	Ipomoea sagittata
Climbing hempweed	Mikania scandens

Appendix 6D. Plant Species Composition (by Percentage) of Ponds and Lakes of Various Size Classes along the Louisiana Coast.

PLANT SPECIES	POND SIZE CLASSES[1]							MEAN VALUES WATER SALINITY (ppt)
	<.01	.01-.10	.10-1.0	1.0-10	10-80	80-640	640-3200[2]	
Alligatorweed (Alternanthea philoxeroides)	0.00	0.00	0.00	0.00	1.01	3.84	2.70	2.73
Waterfern (Azolla caroliniana)	0.00	0.52	0.00	1.69	0.00	0.00	0.00	NA[3]
Carolina bacopa (Bacopa caroliniana)	0.00	0.00	0.00	1.26	0.00	0.00	0.00	2.83
Waterhyssop (Bacopa monnieri)	0.00	12.67	0.00	0.85	2.02	0.00	0.00	3.93
Roundleaf bacopa (Bacopa rotundifolia)	0.00	0.00	0.00	2.53	0.00	0.00	0.00	NA[3]
Watershield (Brasenia schreberi)	0.00	0.00	1.92	5.49	0.00	0.00	0.00	NA[3]
Fanwort (Cabomba caroliniana)	0.00	1.04	0.32	5.07	8.06	0.00	0.00	NA[3]
Spade leaf (Centella erecta)	8.33	0.00	0.00	0.85	0.00	0.00	0.00	2.18

PLANT SPECIES	POND SIZE CLASSES[1]							MEAN VALUES WATER SALINITY (ppt)
	<.01	.01-.10	.10-1.0	1.0-10	10-80	80-640	640-3200[2]	
Coontail (Ceratophyllum demersum)	0.00	3.63	2.88	4.22	2.02	21.43	35.14	NA[3]
Muskygrass (Chara vulgaris)	0.00	1.04	20.50	9.71	10.08	0.00	5.41	1.85
Water hyacinth (Eichornia crassipes)	24.51	0.00	6.28	2.11	0.00	0.00	0.00	2.89
Dwarf spikerush (Eleocharis parvula)	40.20	10.70	4.68	5.32	3.53	8.24	0.00	6.69
Spikerush (Eleocharis sp.)	22.06	26.17	14.41	2.95	0.20	1.65	0.00	3.88
Pennywort (Hydrocotyl bonariensis)	0.00	0.52	0.00	0.00	0.00	0.00	0.00	1.22
Water pennywort (Hydrocotyl umbellata)	0.00	4.46	1.15	0.85	0.00	0.00	0.00	1.22
Spiderlilly (Hymenocallis occidentalis)	0.00	2.08	0.00	0.00	0.00	0.00	0.00	3.69
Willow primrose (Jussiaea sp.)	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.38
Duckweed (Lemna minor)	0.00	9.35	11.34	12.92	5.54	20.88	0.00	1.13

PLANT SPECIES	POND SIZE CLASSES[1]							MEAN VALUES WATER SALINITY (ppt)
	<.01	.01-.10	.10-1.0	1.0-10	10-80	80-640	640-3200[2]	
Frogbit (Limnobium spongia)	0.00	4.67	0.00	0.25	0.00	0.00	0.00	0.45
Variable watermilfoil (Myriophyllum heterophyllum)	0.00	0.00	0.00	1.69	0.00	0.00	0.00	NA[3]
Eurasian watermilfoil (Myriophyllum spicatum)	0.00	0.00	3.20	0.00	26.21	26.92	2.70	NA[3]
Southern Naiad (Najas quadalupensis)	0.00	1.04	5.13	15.20	3.02	0.00	0.00	0.64
American lotus (Nelumbo lutea)	0.00	0.00	1.28	0.00	1.01	5.49	0.00	NA[3]
White waterlilly (Nymphaea odorata)	0.00	1.04	5.13	5.07	4.03	2.20	0.00	0.36
Longleaf pondweed (Potamogeton nodosus)	0.00	0.00	0.00	0.85	0.00	0.00	0.00	NA[3]
Spider pondweed (Potamogeton pusillus)	0.00	0.00	1.60	5.49	1.01	4.95	0.00	NA[3]

PLANT SPECIES	POND SIZE CLASSES[1]							MEAN VALUES WATER SALINITY (ppt)
	<.01	.01-.10	.10-1.0	1.0-10	10-80	80-640	640-3200[2]	
Widgeongrass (Ruppia maritima)	0.00	6.75	10.89	11.40	32.26	2.20	54.05	8.95
Bulltongue (Sagittaria falcata)	0.00	3.42	0.64	0.00	0.00	1.10	0.00	1.70
Bullwhip (Scirpus californicus)	0.00	0.00	0.32	0.00	0.00	0.00	0.00	1.63
Duckweed (Spirodela polyrhiza)	0.00	2.59	0.00	0.85	0.00	0.55	0.00	0.45
Horned bladderwort (Utricularia cornuta)	4.90	8.31	7.69	3.38	0.00	0.55	0.00	0.69

[1]Ponds between 16,000-64,000 ac and greater than 64,000 ac had no measurable plant composition.

[2]Pond size in acres.

[3]NA: No data available.

Source: Chabreck 1972.

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