RESOURCE EVALUATION STUDIES ON THE MATAGORDA BAY AREA, TEXAS

Wayne M. Ahr
Project Coordinator

September 1973

TAMU-SG-74-204

Partially supported through Institutional Grant 04-3-158-18 to Texas A&M University, by the National Oceanic and Atmospheric Administration's Office of Sea Grants, Department of Commerce.

$3.00

Order from:

Department of Marine Resources Information
Center for Marine Resources
Texas A&M University
College Station, TX 77843

CONTENTS

CONTENTS
(continued)

INTRODUCTION

Wayne M. Ahr
Project Coordinator
Department of Geology
Texas A&M University

In October, 1971, the General Land Office of Texas (GLO) and the Texas Bureau of Economic Geology (BEG) initiated a small-scale study on the Matagorda Bay Area of Texas (Fig. 1). The study was intended as a short-term effort to assess man's influence on the physical environment of the bay area. The principal purpose of the study was to furnish information to the GLO in order to help develop an informational base upon which coastal zone management policy guidelines could be made. The Matagorda Bay Area is especially important because it is relatively undeveloped compared to other Texas bays.

On October 1, 1972, Texas A&M University became an active partner in the Matagorda Bay Project. Texas A&M was charged with finding answers to the following four major questions:

1. What are the water circulation patterns of Matagorda Bay and how does water circulation affect processes such as coastline change and pollution dispersal among others?
2. What is the chronic pesticide and PCB (polychlorinated biphenyls) level in bay sediments and what are the physical-chemical variables that govern the distribution and retention of chlorinated hydrocarbons in the sediments?
3. What are the occurrences and distribution patterns of selected benthic microfauna and will data on microfaunal populations

elucidate processes of coastal change, pollution and water circulation?

4. What is the economic structure of the Matagorda Bay area and how may changes in population, resources and transportation affect its future economic structure?

The four problem areas were investigated by four teams. Each team functioned as a part of Texas A&M's Matagorda Bay Project.

The Texas A&M Study in Perspective

In the period 1971-1972 the GLO and the BEG completed historical survey of physical and cultural boundaries in the study area. A series of maps is being prepared by BEG to illustrate the amount and kind of shoreline change that has taken place over approximately the last 40 years. During 1972-1973 the GLO/BEG efforts have focused on preparation of bay sediment maps, determination of the heavy-metal pollutants in the bay sediments, and analyses of interstitial water.

To date, the BEG has collected samples from essentially all parts of Matagorda Bay. One hundred grab samples were taken during 1971-72. Six hundred grab samples and 60 short cores have been planned for 1972-73.

The thrust of the BEG effort, in essence, has been to establish the pattern of shoreline change and determine the geologic character of the bay sediments.

The Texas A&M studies complement those done by the BEG in that the distribution patterns of sediments, pollutants and benthic microorganisms depend, to a great extent, on water circulation patterns. The amount and location of heavy-metal pollutants in bay sediments are more meaningful when considered together with the pesticide and PCB pollution patterns. Although the BEG has studied the distribution of some

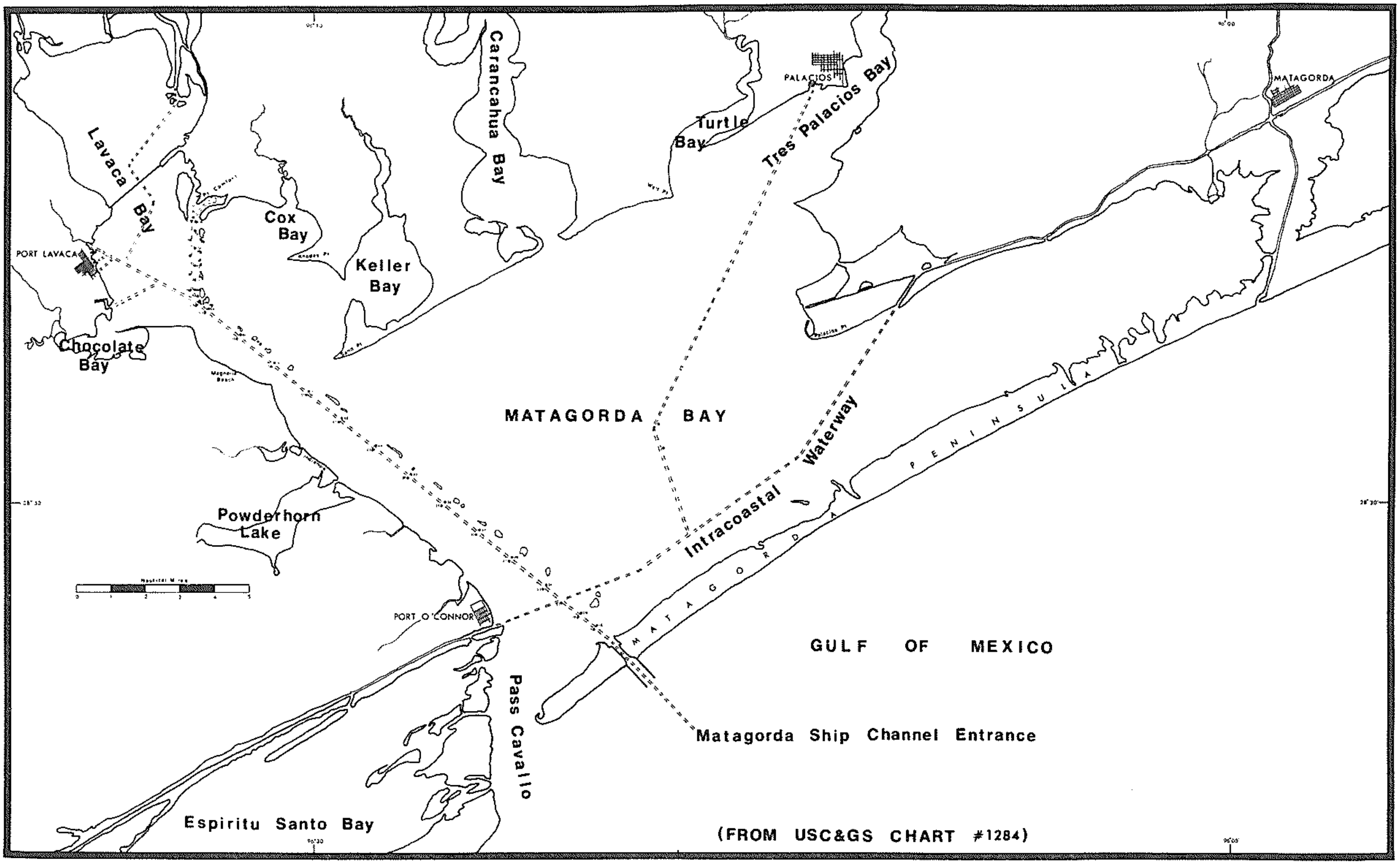

MATAGORDA
PALACIOS
Tres Palacios Bay
Turtle Bay
Carancahua Bay
Lavaca Bay
PORT LAVACA
Chocolate Bay
Cox Bay
Keller Bay
MATAGORDA BAY
Intracoastal Waterway
MATAGORDA PENINSULA
Powderhorn Lake
PORT O'CONNOR
Pass Cavallo
GULF OF MEXICO
Matagorda Ship Channel Entrance
Espiritu Santo Bay
(FROM USC&GS CHART #1284)

FIGURE 1

biologic forms in the bay, microgastropods, ostracods and benthic foraminifera have not been examined. Finally, the economic assessment of the Matagorda Bay Area provides a useful data base with which to evaluate the bay environment, its natural resources and the most effective means to develop those resources in a manner compatible with present environmental quality.

Acknowledgments

This study was funded by the National Oceanic and Atmospheric Administration Sea Grant Program at Texas A&M University. Matching funds were contributed by Texas A&M University, Parker Brothers and Co., Inc., and The General Land Office of Texas.

The help of Dr. Joseph McGowan, Texas Bureau of Economic Geology, is gratefully acknowledged.

The workers on the project benefited from discussions with the staff of the Environmental Planning Division of the General Land Office.

BAY CIRCULATION

Barry Holliday*
Department of Oceanography

INTRODUCTION

The Matagorda Bay estuary includes approximately 350 square miles and consists of the Lavaca and Navidad Rivers and other tributaries, Lavaca Bay, Chocolate Bay, Cox Bay, Keller Bay, Powderhorn Lake, Carancahua Bay, Turtle Bay, Tres Palacios Bay, Matagorda Bay, Matagorda Ship Channel entrance, Pass Cavallo and portions of the Intracoastal Waterway (Figure 1). The average water depth of Matagorda Bay at mean low water is 13 feet or less, except in the Matagorda Ship Channel, which is more than 40 feet deep (Hahl and Ratzlaff, 1972). The 200-foot wide ship channel extends 22 miles from Matagorda Peninsula to Point Comfort. Several spoil islands are on the eastern side of the ship channel.

The Intracoastal Waterway is the same depth as Matagorda Bay and does not act as a channel nor significantly affect the flow of water through the bay. Under normal weather conditions and average rainfall, the tributaries flowing into the various small bays discharge nominal

---

*Credit for authoring each of the four sections of this report is given at the beginning of the section. Each section has been edited by the Project Coordinator in order to aid in maintaining compatibility of style and content between sections and to avoid duplication of effort.

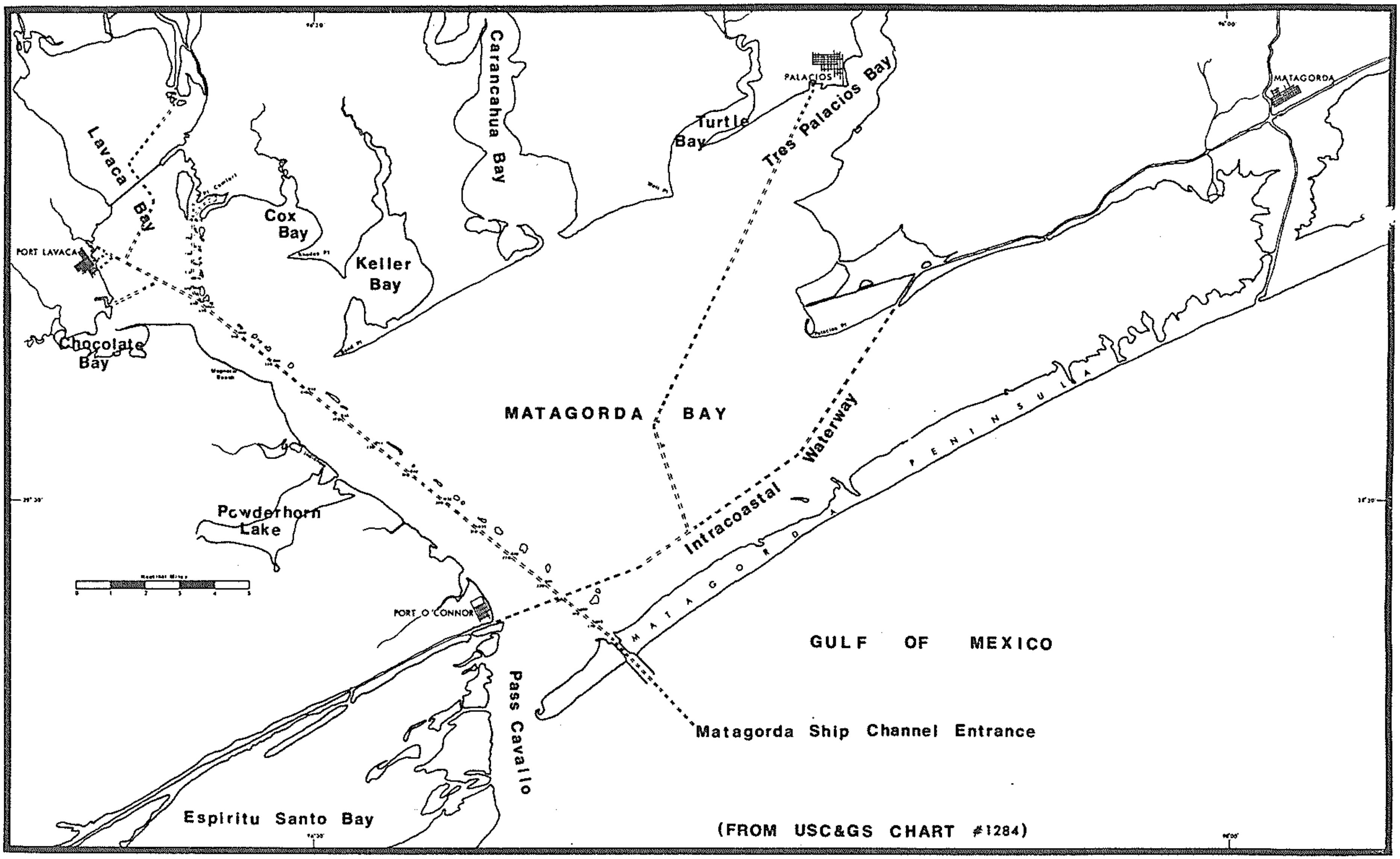


Figure 1.

Location of the Matagorda Bay Estuary

volumes of fresh water compared to the major Texas rivers. However, during periods of high rainfall these tributaries may still reduce the salinity of Matagorda Bay (TWDB Report 144).

Methods

The data used for investigation of Matagorda Bay estuary circulation patterns include tide gage records, over-flight imagery, TWDB-USGS estuary data, current meter data and bottom drogue data.

The tide records were obtained from the U.S. Geological Survey in Houston and included the 1970, 1971 and 1972 water years. There were eight tide gage stations utilized from various positions within the Matagorda Bay estuary (Figure 2). There are other tide stations in the bay and earlier records. However, these other stations and records are generally not continuous enough for this qualitative study. Some of the tide records used in this study are from stations that do not have a precise datum established or that have clocks set incorrectly on the strip charts. Thus, actual slope measurements of the tidal wave cannot be computed and lag times can only be approximated. Nevertheless, it can be seen from tide record plots from different stations (Figure 3) that the character of the period and magnitude of the tidal fluctuations are very similar. This similarity suggests that the actual tidal wave must travel through the bay without any significant drag from reefs or spoil banks. The computer model of Shankar and Masch (1970) (Figure 4), which depicts the equilibrium salinity distribution in Matagorda Bay, supports the low-drag idea. Also, there is excellent agreement between the Shankar and Masch model and the physical model of Simmons and Rhodes (1966).

The tidal period in Matagorda Bay fluctuates from diurnal to

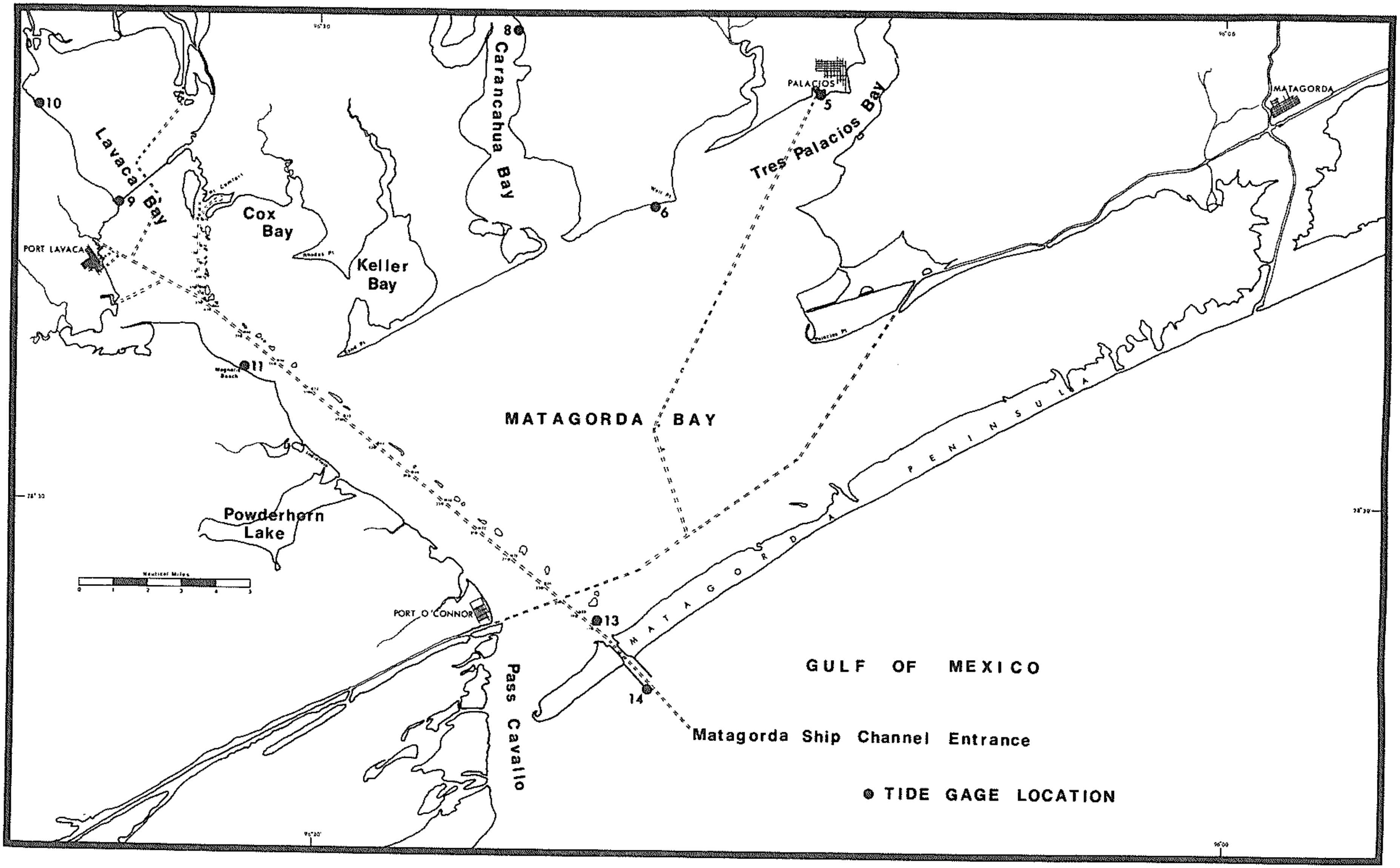


Figure 2
Location of Tide Gages in Matagorda Bay

semi-diurnal (Figure 5) generally twice during each thirty day period. The diurnal tide has a 24 hour period with one high or flood tide and one low or ebb tide about 12 hours apart. The diurnal tide occurs for eight days followed by five to six days of semi-diurnal tides having two highs and two lows in 24 hours. Investigations of the near-Gulf gages (numbers 14 and 13 from Figure 2) show that as the tide approaches a semi-diurnal period a slack tide can persist for as much as nine hours (Figure 5). This extended slack flood causes a gradual increase in the maximum height of the upper bay gages but decreases the fluctuation from ebb to flood tide to 0.2 to 0.5 feet (normal height is 1 - 1.2 feet). ERTS-A photographs of the area taken during one of these periods reveal confused turbidity patterns within the Bay, suggesting a reduction in current velocities and durations.

Another major factor that affects the tide is the direction and force of the wind. The passage of a winter "norther" can rapidly change the water level within the bay (Figure 6). Strong southeast winds and fronts moving inland from the Gulf of Mexico tend to drive water into the bay and build tide heights two to three feet above normal.

A few current velocity measurements were made during this study with a Gurley 665 direct reading current meter, bottom drogues and dyes. Current meter and dye measurements were made at eleven stations (Figure 7) and drogues were used at two stations (7 and 8, Figure 7). This information does not include any comprehensive winter data and all evaluations of currents and circulation are based on relatively calm periods.

The current speeds measured at various times during the study at eleven stations vary considerably (Table I). However, inspection reveals a pattern of higher velocities at ship channel stations (3, 4, 5, 6) and the Pass Cavallo station (7) with lower velocities occurring at stations 9,

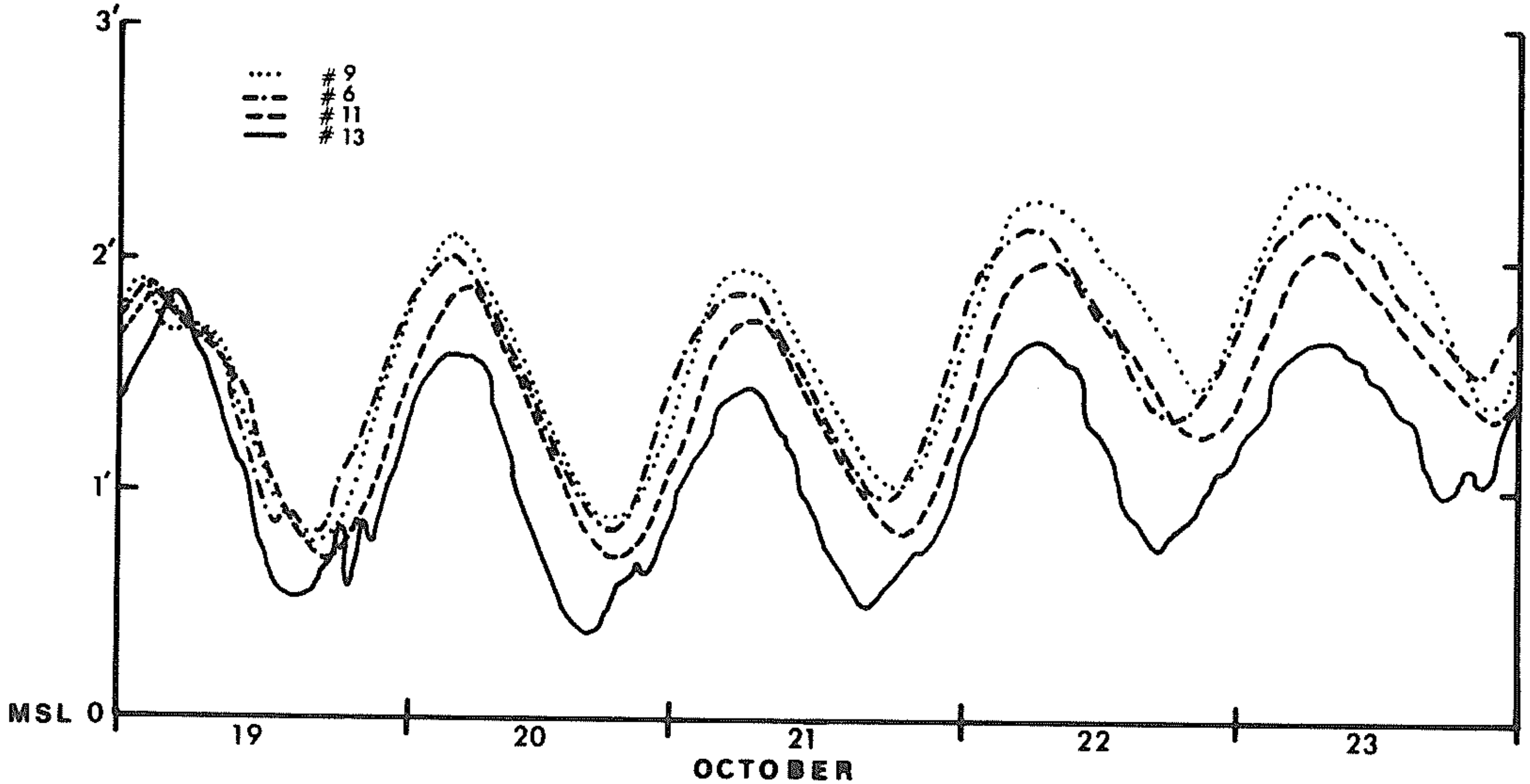
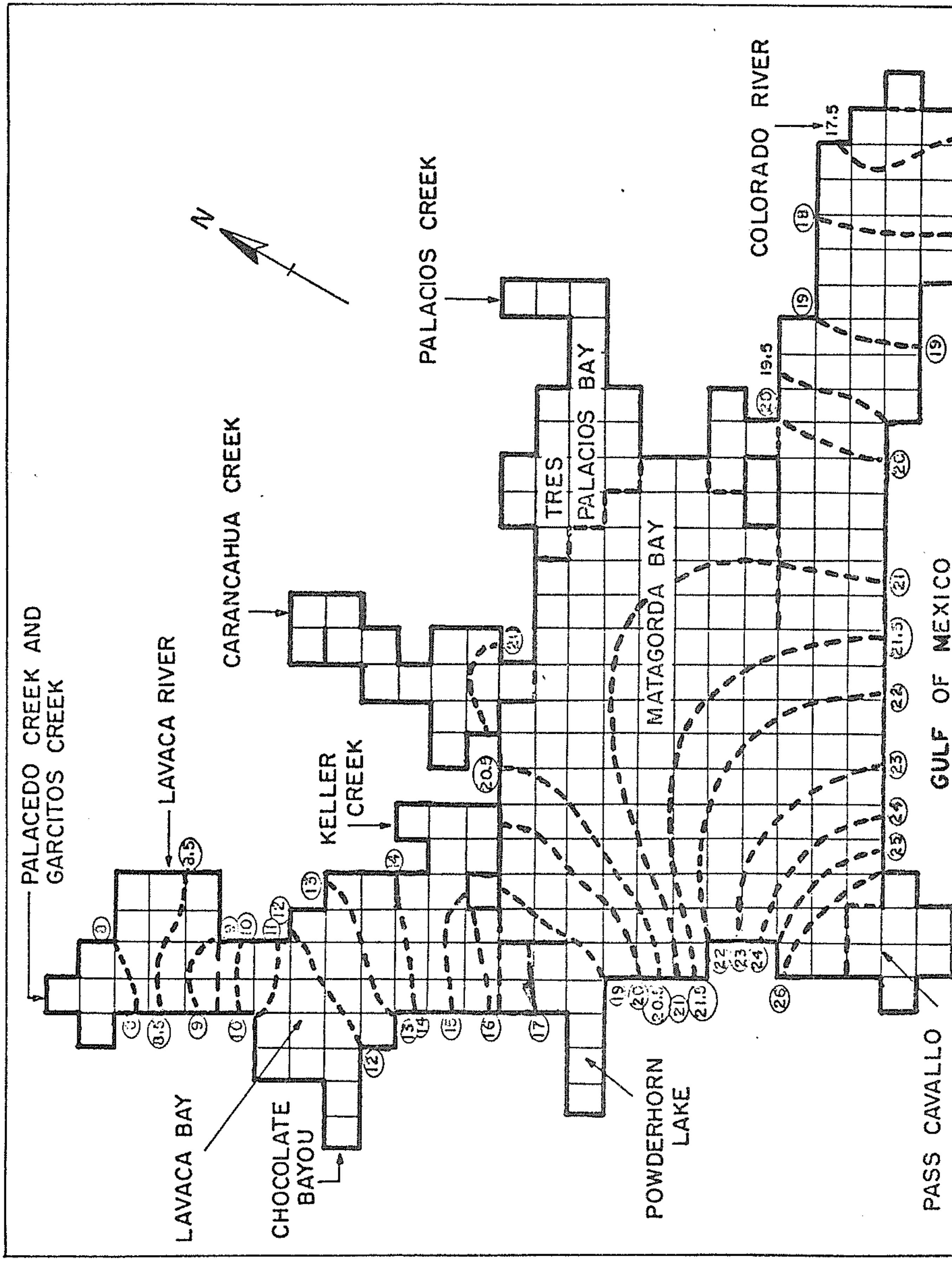


Figure 3

Tide Records of 4 Tide Gages in Matagorda Bay

During the Same Time Period



Computer Model of Salinity Distribution in Matagorda Bay
At Equilibrium. (After Shankar and Masch, 1970)

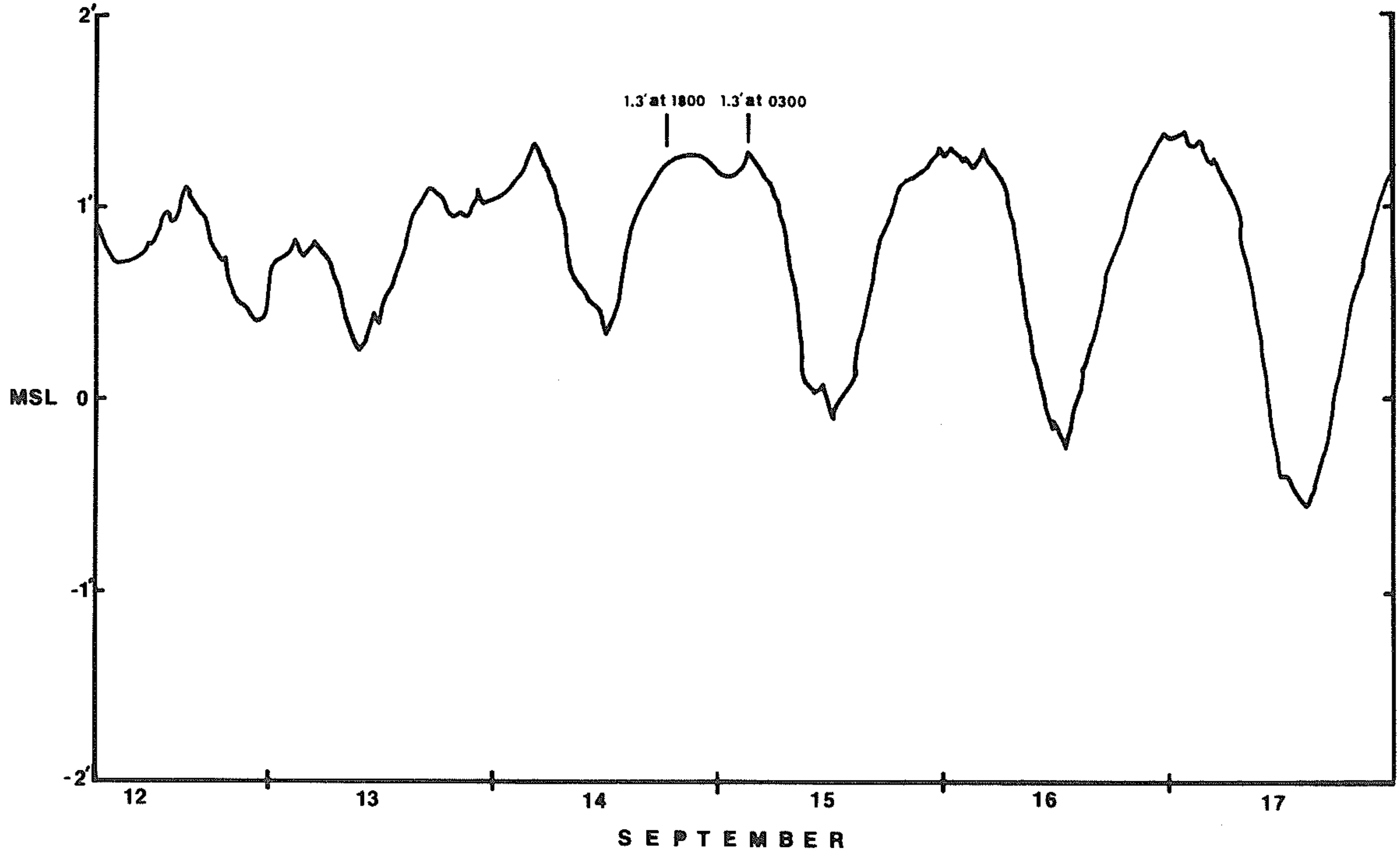


Figure 5.

Tide Gage Records from South Jetty of Matagorda Ship Channel Entrance Showing Change from Semi-Diurnal on the Left To a Diurnal Tide on the Right

10, and 11. Station 8, being near the major input source of the Gulf water, has high current velocities. The maximum current velocity of 11 feet per second occurred at station 6 and was measured on two different occasions.

A general circulation pattern can be developed for both ebb and flood tide (Figures 8,9) by correlating the current meter data and the observations of water movement from NASA over-flight imagery. This pattern is a generalized but functional means of predicting problem areas. Erosional areas and areas of slow circulation can be determined. Essentially the western side of Matagorda Bay from Pass Cavallo to a point just west of Sand Point at Lavaca Bay will experience the greatest water movement. Central and eastern Matagorda Bay will not have high velocity water movement but will be flushed by each tidal cycle. As in most Texas bays the Matagorda Bay ebb tide builds to the west and a component is set up along the northern shore of the bay between Well Point and the ship channel at Sand Point.

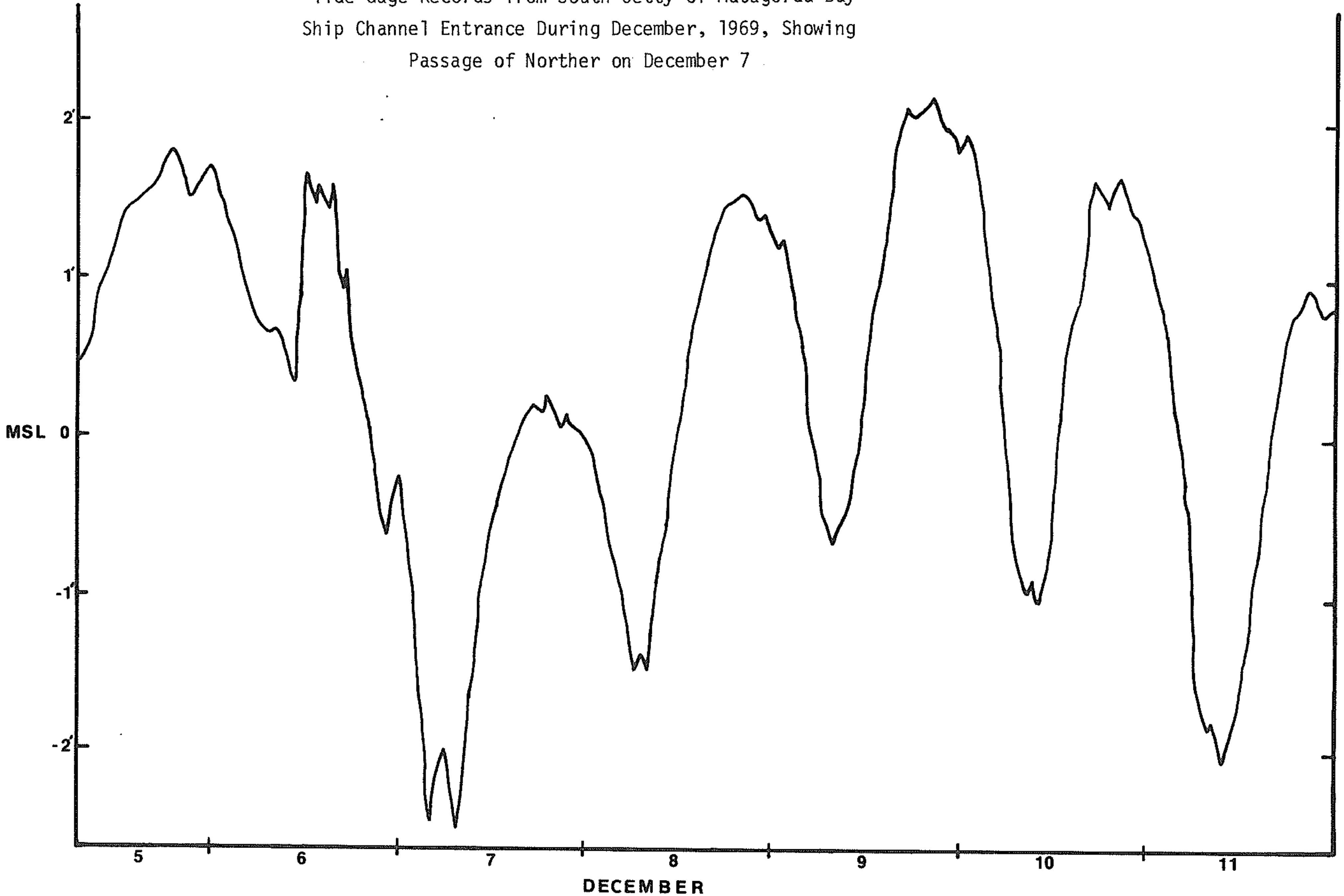
CONCLUSIONS

Understanding the tidal circulation in Matagorda Bay can enable one to predict the character of the tidal period and amplitude, thereby permitting better planning and development of the estuarine environment. In Matagorda Bay this is important because the periphery of the bay is essentially undeveloped as compared to other Texas bay areas.

Based on the tidal data, the critical period when flushing is reduced and circulation is confused occurs during the semi-diurnal tides. This would be a hazardous time to discharge any foreign material or to clean sewage treatment tanks near the bay as the flushing action of the tide is decreased and any discharge would remain concentrated. This could

Figure 6

Tide Gage Records from South Jetty of Matagorda Bay Ship Channel Entrance During December, 1969, Showing Passage of Norther on December 7



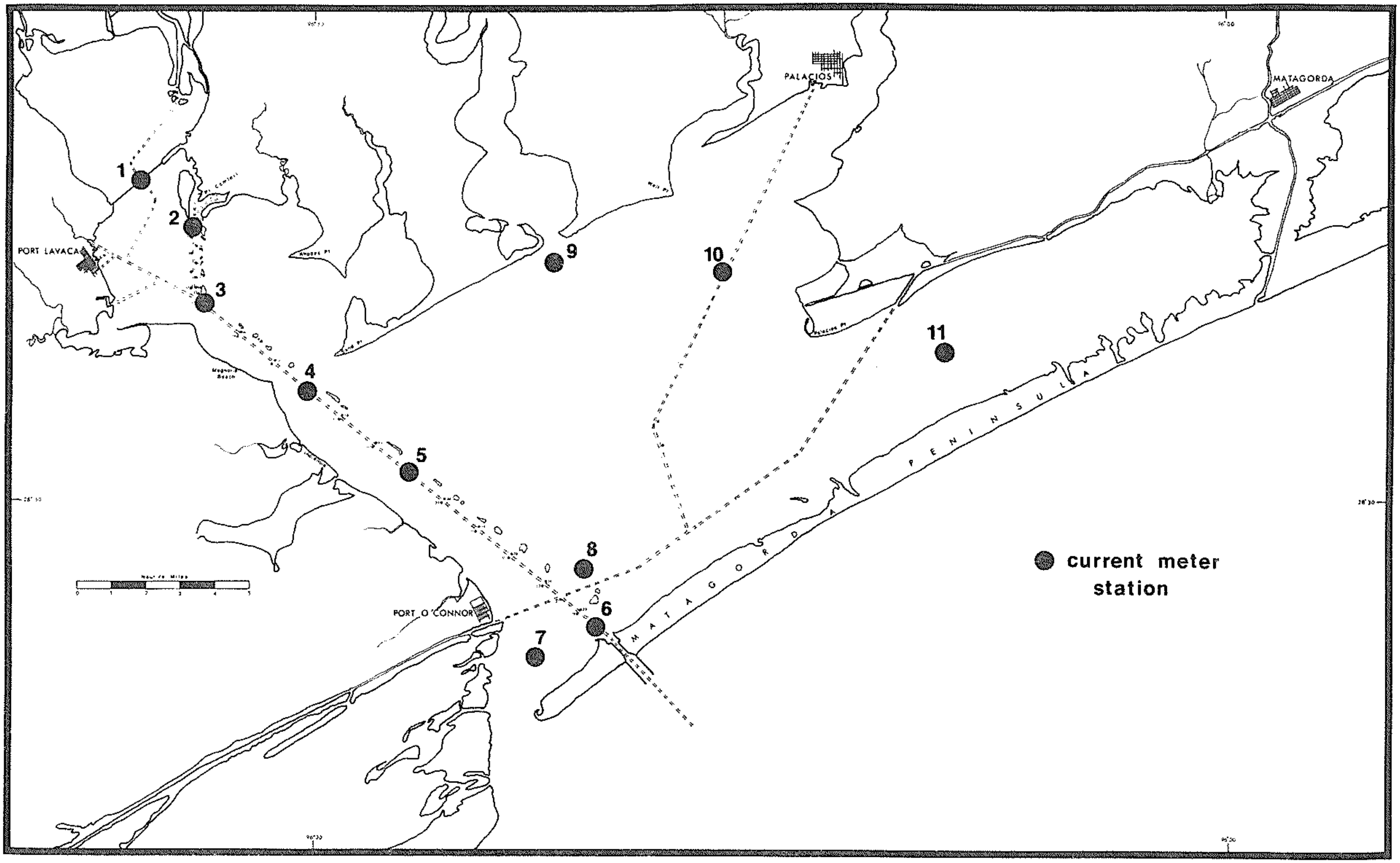


Figure 7

Location of Current Meter Stations in Matagorda Bay

TABLE I

CURRENT DATA FROM GURLEY 665 CURRENT METER
TO SHOW RELATIVE SPEEDS AT VARIOUS PLACES WITHIN
MATAGORDA BAY

Station Number Number (See Figure 7)	Surface Values in Feet Per Second			
1	1.3	0.6	0.6	4.1
2	2.1	0.8	1.6	6.0
3	1.5	1.4	1.0	7.9
4	1.9	2.0	2.2	7.6
5	4.7	4.1	2.2	7.8
6	6.7	5.0	2.8	9.7
7	6.2	5.8	2.3	9.2
8	6.6	5.3	2.4	8.8
9	1.4	.9	0.4	2.4
10	1.1	.7	0.5	3.1
11	0.8	.7	0.5	1.6

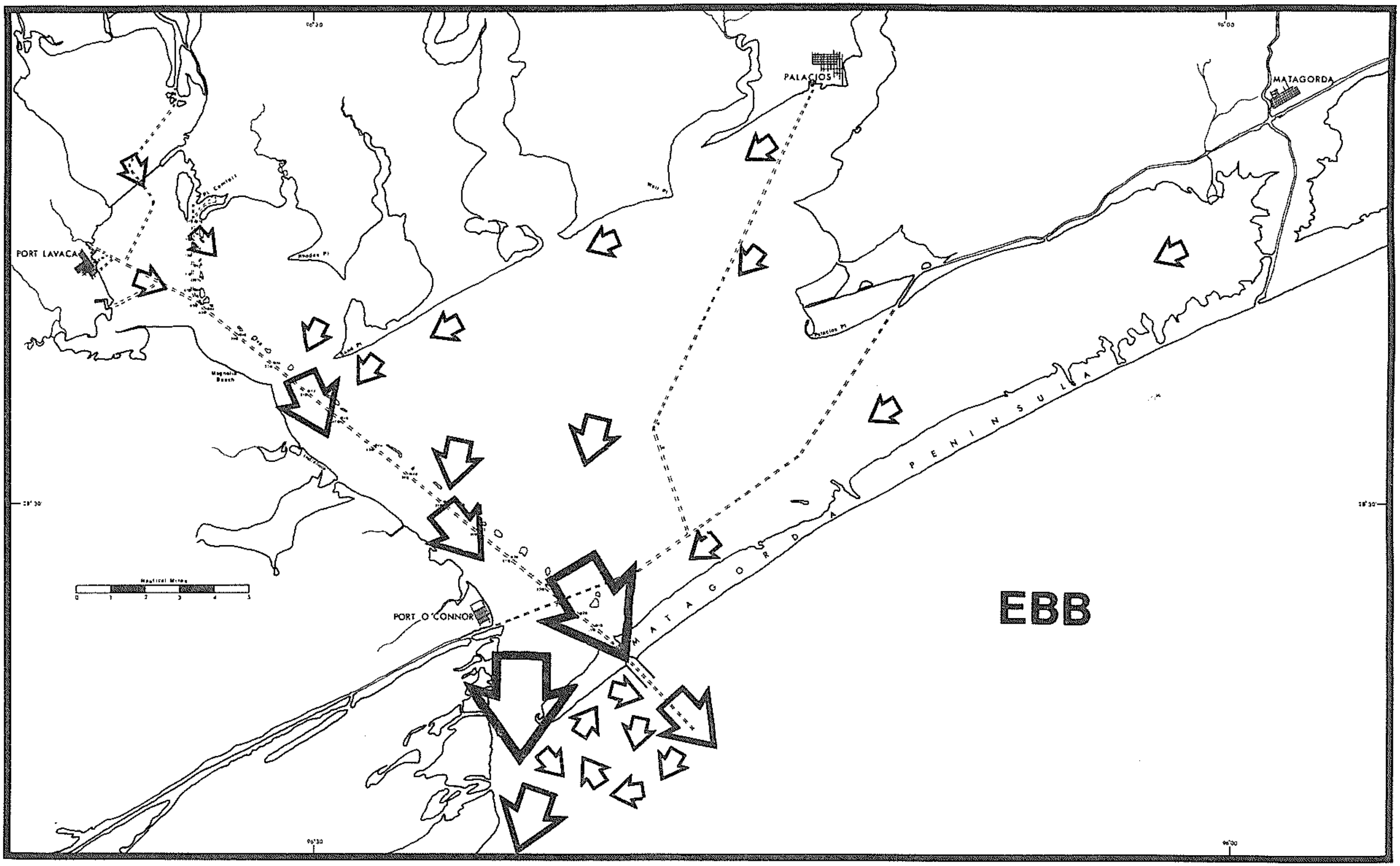


Figure 8

General Circulation During Ebb Tide in Matagorda Bay

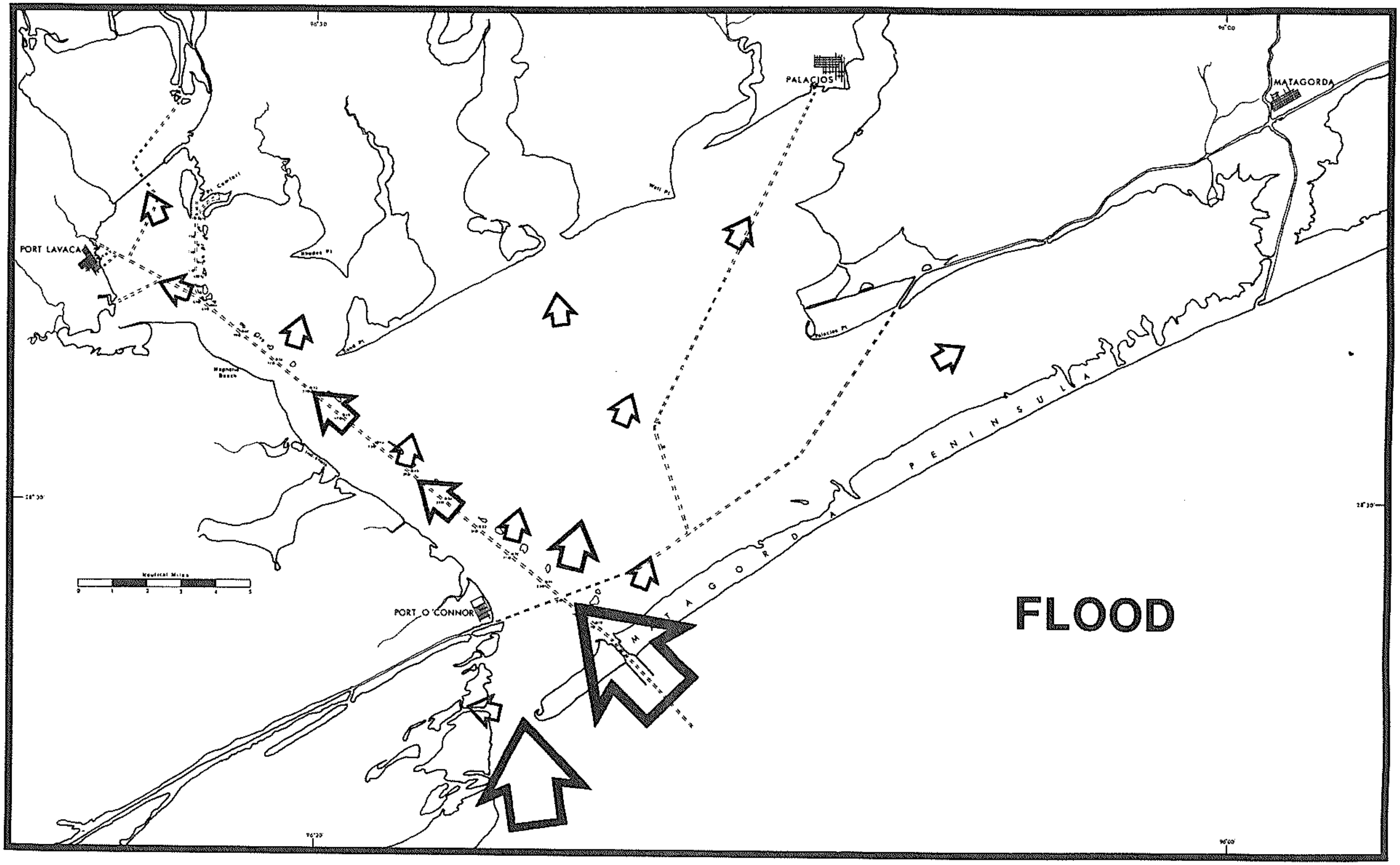


Figure 9

General Circulation During Flood Tide in Matagorda Bay cause excessive stress on the biologic community in the immediate area, or it may cause unsightly deposition of foul smelling substances or unsightly material on a beach or in a marina area. This hazard is more pronounced in the upper bay areas where the water level often increases above the reaches of normal tidal action.

The erosional effect of high velocity currents is an important factor to consider in the planning of waterfront housing developments and recreational facilities such as marinas and beaches. The area of most concern in Matagorda Bay is along the western shore from Port O'Connor to above Magnolia Beach where high velocities are predominant. This area has a history of rather high erosional rates and should be approached with caution in future planning of waterfront housing and recreation. Special attention should be given to wave action during storms. A more positive characteristic of this western shore is its high flushing rate compared to upper Lavaca Bay or the eastern part of Matagorda Bay.

The ship channel enhances circulation and flushing in lower Lavaca Bay where the major industrial activity exists. The tidal range is sufficient to maintain a substantial circulation in Lavaca Bay and the surrounding areas. Tres Palacios Bay does not possess current velocities of the magnitude found in the ship channel area and represents less saline, lower energy bay. However, with a tide range of nearly one foot the bay does have good circulation most of the time. Matagorda Bay is one of the deepest Texas bays and does not contain a large number of hazardous reefs or shoals. The bay is also accessible from many different places along its shore. Thus, the bay with its two direct inlets to the Gulf of Mexico is a good recreational bay and maintenance of adequate circulation will keep the bay's ecologic potential high.

BIBLIOGRAPHY

Hahl, D.D. and Ratzlaff, K.W., 1972, Chemical and Physical Characteristics of Water in Estuaries of Texas, October 1968 - September 1969, Texas Texas Water Develop. Board, Rept. 144, 161 p.

Shankar, N.J. and Masch, F.D., 1970, Influence of Tidal Inlets on Salinity and Related Phenomena in Estuaries, Tech. Rept. HYD 16-7001, Hy. Eng. Lab, Univ. of Texas, 107 p.

Simmons, H.B. and Rhodes, H.J., 1966, Matagorda Ship Channel Model Study, Matagorda Bay, Texas, Tech. Rept. No. 2-711, U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi, 215 p.

CHLORINATED HYDROCARBONS IN SOME MATAGORDA BAY SEDIMENTS

Wayne M. Ahr and James Daubenspeck
Department of Geology

INTRODUCTION

Pesticides and organometallic complexes may become sorbed on clays and organic detritus (Bader and Others, 1960; Huang and Liao, 1970; Huang, 1971; Harriss, 1971) thereby becoming integral parts of the natural sediment load in a drainage system. As the sediments reach lakes, estuaries or bays, they are deposited. These deposits become sinks for the sorbed pollutants (Ahr, 1972). Because many chlorinated hydrocarbon pesticides are very persistent (DDT has a half-life of up to 17 years, according to Nash and W-olson, 1967), they may constitute an environmental hazard for years after application. Ahr (1973) has shown that even a few parts per billion of DDT in the coastal ecosystem may be harmful to wildlife because DDT is "magnified" exponentially through the higher ecological levels.

Purpose of the Study

The purpose of this study is to answer the following questions:

1. How much DDT, DDE and PCB are in surface sediments from Western Matagorda and Lavaca Bays?
2. Are there pollution concentrations in the study area?

3. Where did the chlorinated hydrocarbon pollution come from and how did it get to its present location in the bays?
4. How do DDT, DDE and PCB data figure into the future use and management planning programs for the bays of the study area?

Methods

Data for this study were 1) collected from direct observations in the field and the laboratory, 2) derived from analytical procedures in the laboratory, and 3) collected from the literature and other information sources.

Field procedures included establishing 45 sample stations (Fig. 1) in the study area, collecting sediment samples at each station and monitoring water depth, temperature, salinity and conductivity during the sediment sampling procedure.

Prior to sample collection in the field, pint jars were washed in Alconox, rinsed with distilled water, then rinsed again with acetone. The distilled water used throughout this study was tested to insure that it was free of DDT, DDE, or PCB's.

The 45 sample stations were chosen to give geographic coverage of Western Matagorda Bay and to cover the major river inputs into the study area. Sampling was done from the 39 foot cabin cruiser, the LaMer II. Upon arrival at a station, a sample of the bottom sediment was taken with an Eckman Dredge sampler. The upper 1 centimeter of the sample was skimmed off and placed into one of the previously cleaned pint jars. Temperature, salinity, and conductivity data were monitored with a YSI Model 33 SCT meter. Approximately 1 pint of sediment was taken to obtain enough sediment for replicate analyses. In route to the next station, all equipment was thoroughly rinsed in sea water and acetone.

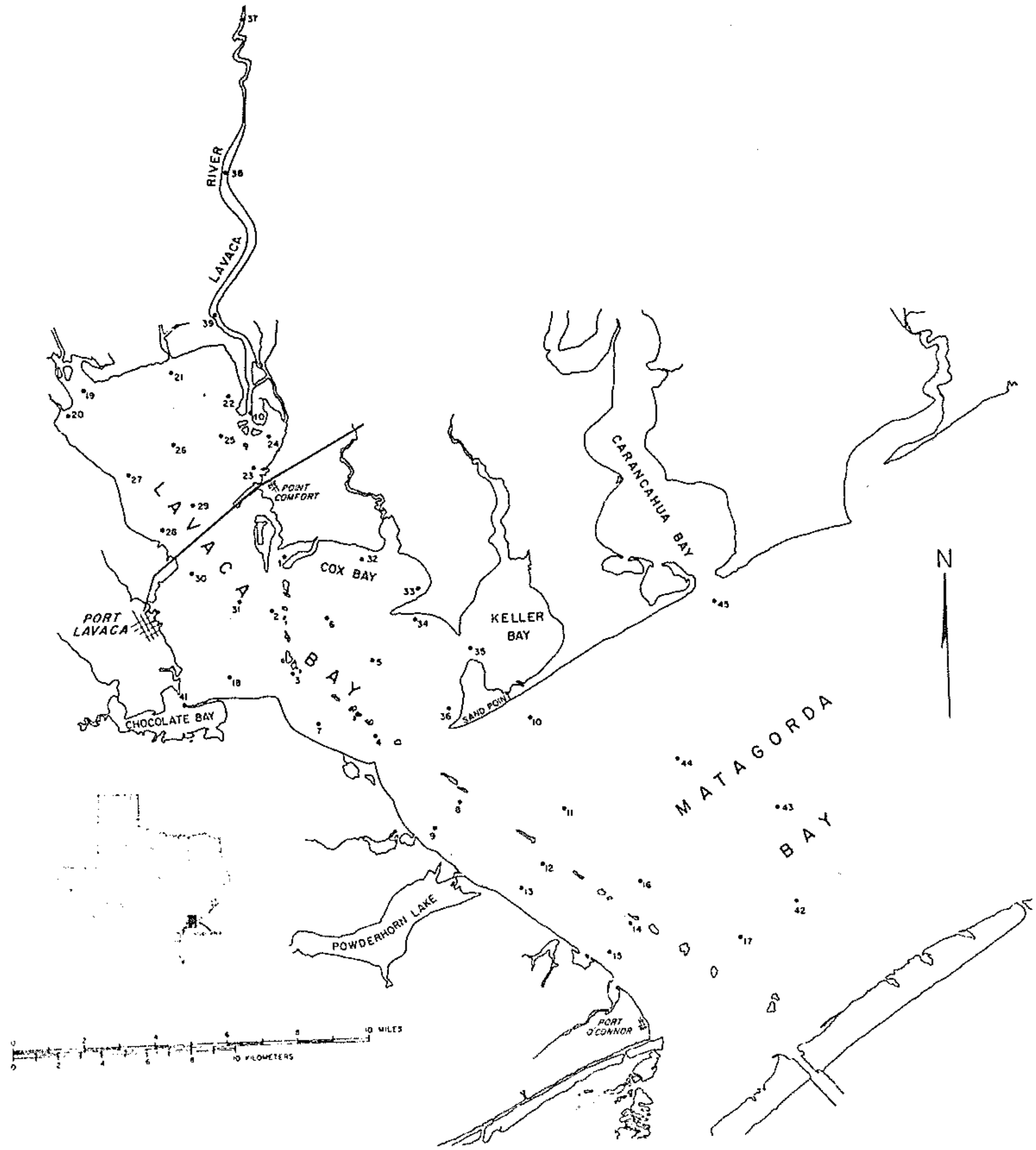


Figure 1.

Location of the study area showing the 45 sample stations.

After the samples were taken back to the laboratory, each was washed through a 0.062 mm (No. 230) sieve with distilled water to separate mud from sand. The mud was collected in 8 by 11 inch pyrex dishes and allowed to dry. The coarse fraction remaining in the sieve was collected and permitted to dry for further description. After each mud sample had dried, a minimum of 20 grams was weighed out and put into pre-washed glass vials. Pan American Laboratories, Brownsville, Texas, conducted the analyses for DDT, DDE, and PCB concentrations in the mud samples.

The next laboratory procedure was to describe the coarse fractions which remained after the samples had been washed. A small portion of the raw sample was wetted and a slurry prepared. From this slurry, the color and estimated coarse-fraction percent were determined. The dried coarse fraction was saved after sieving and was examined under a binocular microscope to determine its composition. Sample descriptions are on file in the Department of Geology, Texas A&M University.

Pan American Laboratories analyzed for DDT and DDE concentrations in the following manner: each sample was prepared into a water slurry and shaken for one hour with 100 ml of benzene. The benzene layer was then filtered through disodium sulfate and concentrated. The DDT values were determined by electron capture gas chromatography, using suitable polar and nonpolar columns.

PCB values were determined through the following procedure: the sample was moistened and shaken for one hour with 150 ml of acetonitrile, filtered, and evaporated to dryness. Twenty-five ml of 2.5 percent alcoholic potassium hydroxide were added and the solution was refluxed for 45 minutes. The sample was transferred to a separator and extracted with hexene. This hexene extract was reduced to 5 ml and transferred to an alumina column (activated at 400 degrees centigrade) for 4 hours and deactivated with 5 percent weight by weight of water. This preparation was then eluted with 100 ml of hexane, concentrated and run by electron-capture gas chromatography at 200 degrees centigrade on a six foot by one quarter-inch Pyrex column, 1.5 percent OV-17 + 1.95 percent OF-1, with a chart speed of 1 inch per minute. Confirmation was done on a six foot by one quarter-inch Pyrex column, with DC-200 on Gas-Chrom Q.

Previous Work

Other than the work just completed by the BEG, there has been little previous work on the pollution content of present-day (surface) Lavaca and Matagorda Bay sediments. The BEG work has focused on heavy-metal pollutants; therefore, there has been no systematic study of the chlorinated hydrocarbon content of the bay sediments.

Some earlier studies have included scattered pesticide analyses from the Lavaca-Matagorda Bay system. These studies were conducted by the Texas Parks and Wildlife Department (Ray Childress, written communication) and the Texas Department of Agriculture (Brooke Tidswell, written communication). These studies were primarily biological or hyrological in nature and were regional in extent: they did not systematically cover Matagorda or Lavaca Bay.

RESULTS OF THE STUDY

DDT and DDE in the Study Area

DDT (dichlorodiphenyltrichloroethane) and one of its metabolites -- DDE (dichlorodiphenylethane) -- were detected in small amounts in all 45 samples from the study area. Ten of the 45 samples contained less than 2 parts per billion p-p' DDT; all others contained p-p' DDT up to a maximum of 36 parts per billion in the sample from Chocolate Bay south of Port Lavaca (sample 41). All samples contained more than 2 parts per billion (ppb) of p-p' DDE. The highest DDE value is 28 ppb, also from site 41.

The resolving power (limit of detection) of the analytical device used by Pan American Laboratories is 2 parts per billion. For DDT and DDE, the values presented in this report are reproducible within plus or minus 30 percent. For PCB's, the stated values in this report are reproducible within 50 percent. The values of p-p' DDT and p-p' DDE determined in this study are shown in Figures 2, 3, and 4. No PCB's were detected in any of the 35 selected samples analyzed.

Factors Governing Chlorinated Hydrocarbon Distribution in the Study Area

The factors that govern the location and amount of DDT, DDE and PCB in bay sediments are numerous. They can be set up according to category in the following fashion:

1. Geological - the host material on which the pollutants sorb; the dispersal and deposition of polluted sediments.
2. Physical - water motion; the transporting mechanism.
3. Biological - the amount of mixing and ingestion/excretion of the pollutant by organisms, mainly after initial deposition.
4. Chemical - the sorption and desorption mechanism; the degradation of chlorinated hydrocarbons in the bay environment; the levels of toxicity of the primary pollutants and their breakdown-products.

This study is mainly concerned with items 1 and 2: the geological and physical factors involved in the processes of chlorinated hydrocarbon

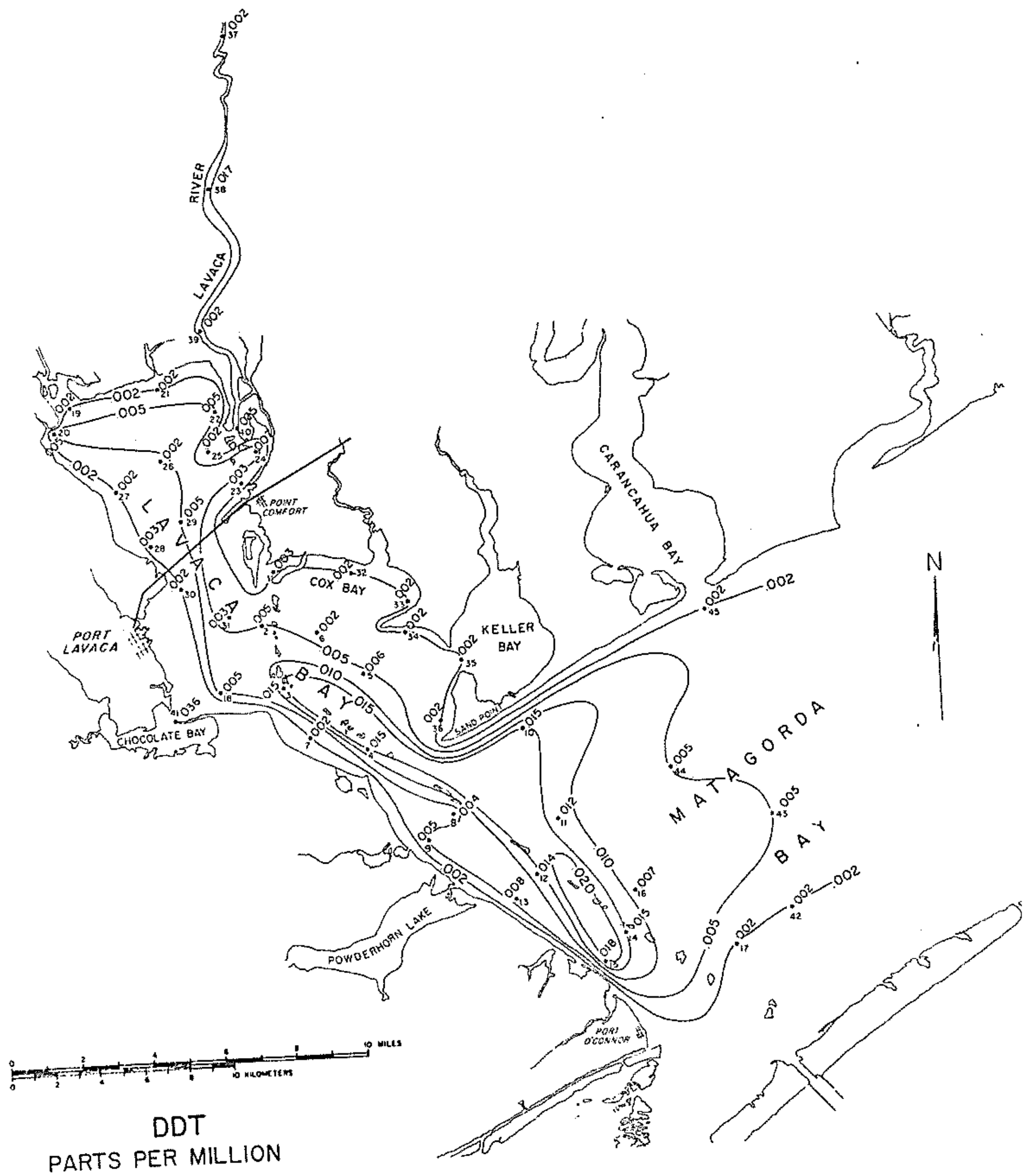


Figure 2.

A map of the p-p' DDT content of surface sediments in the study area.

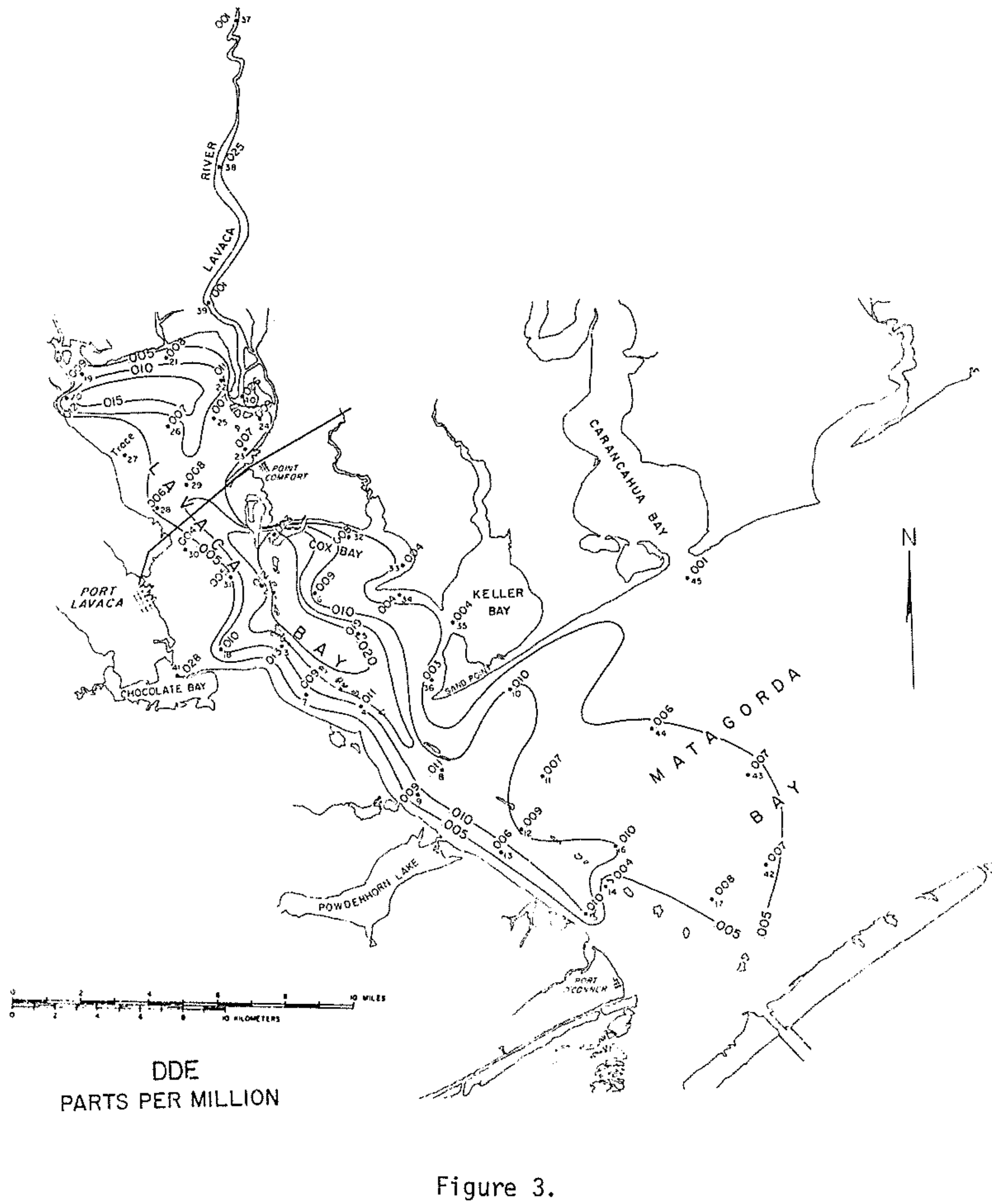


Figure 3.

A map of the p-p' DDE values from sediments in the study area.

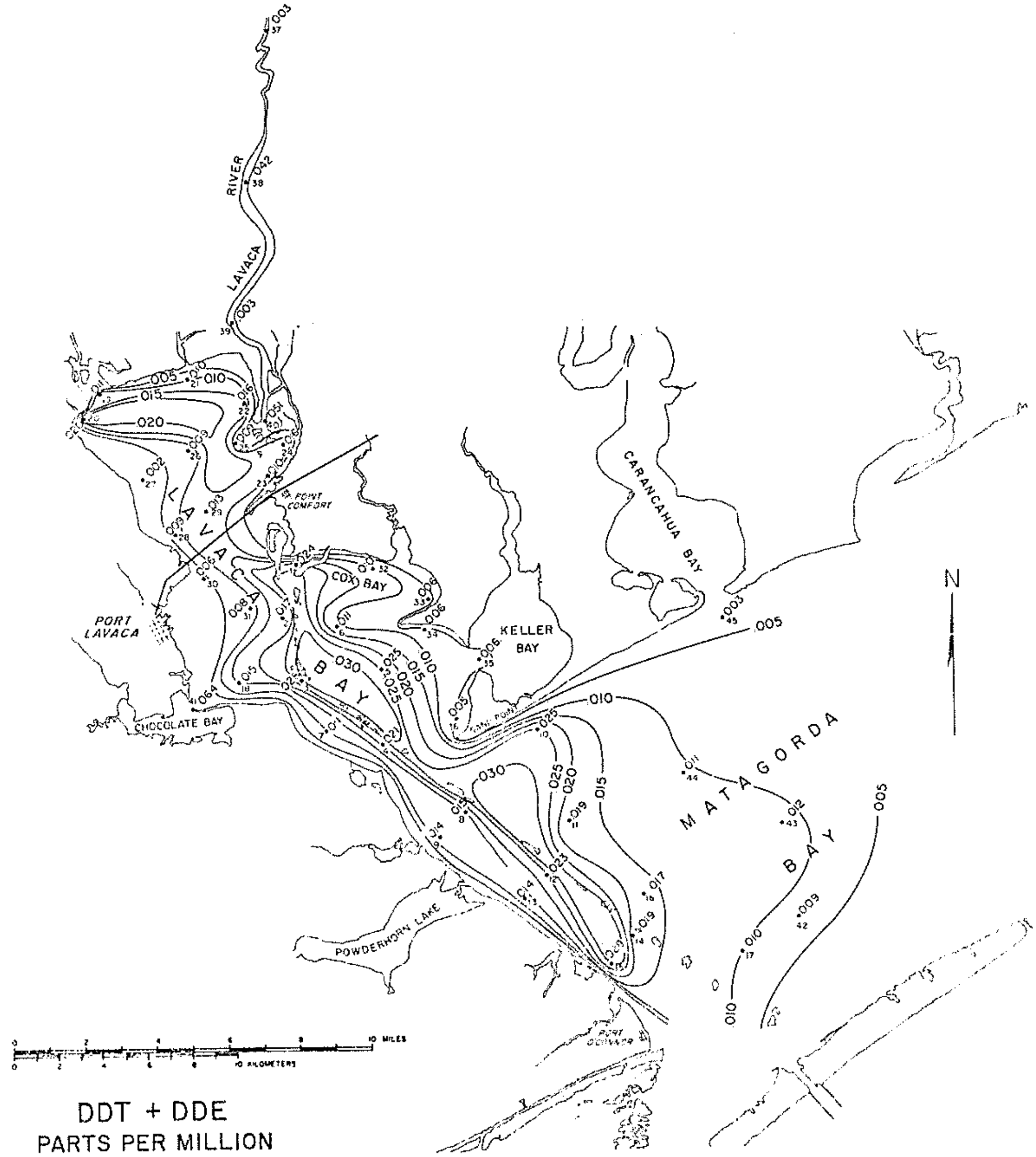


Figure 4.

The DDT plus DDE content of sediments in the study area.

pollution.

Among the more important geological factors which affect chlorinated hydrocarbon pollution in the TExas coastal environment are:

1. The amount and kind of sedimentary particles that move through drainage systems and into the coastal zone.
2. The sediment load - particularly the suspended load - of the streams.
3. The nature of land-use in the drainage basin (cultivated, native grass cover, etc.).
4. The rate and pattern of sediment deposition or erosion in the bay or lagoonal environment.

The more important physical factors include:

1. The location, magnitude and direction of water currents.
2. The output of currents and the driving force behind them.
3. The relative flushing rates of various bay areas.

The amount and kind of sedimentary particles which affect chlorinated hydrocarbon pollution are determined by:

1. Evaluating the sediment load at a point.
2. Separating the sediment load into its essential mineral constituents.

The Matagorda Bay study has not included a study of the major mineral constituents of the sediment samples which were collected because the BEG is conducting an exhaustive sedimentological survey of the bay area.

In a study of the nearby San Antonio Bay area, Ahr (unpublished report, 1973) found typical bay sediments to consist of mixtures of montmorillonite (a clay mineral), quartz, calcite, and the clay minerals kaolinite and illite - in about that order of abundance. All bay sediments also contain varying amounts of organic detritus. One measure of the amount of organic matter is the organic carbon content of the sediments. Most San Antonio Bay sediments contained about 0.6 percent organic carbon by weight. Organic carbon percentages from Matagorda Bay sediments varied from 0.1 to over 1.0 (These data were supplied by the BEG and were not taken from samples collected by Texas A&M).

DDT, DDE and PCB's adsorb on mineral grains and on organic detritus. The pollutants are relatively insoluble in water; but they are quite soluble in lipids (fats) which may make up a part of the organic detritus in the sediment load. There is a decided preference for certain parts of the sediment load as hosts for DDT, etc. In general, the clay minerals and the organic matter are the most effective "sponges" for DDT and PCB's, and lipid-rich organic matter is a more effective DDT scavenger than non-fatty debris. Quartz (the main constituent of beach and river sand and silt) is less effective as a DDT/PCB scavenger, according to unpublished data by Ahr. And, like quartz, calcite (shelly material) is a relatively poor host to chlorinated hydrocarbons because its crystallographic structure is "closed" compared to the mixed-layer clays such as montmorillonite. Sorption efficiency, in the case of calcite and quartz, is more a function of exposed surface area (grain size) than of mineralogy.

Sediments entering Lavaca and Western Matagorda Bay system are brought in primarily by the Lavaca River. Local creeks and rills discharge sediment into the bay also, but data on these sources of sediment are not available.

Childress (written communication) estimates that the "silt" load of the Lavaca River averaged over 17 years (ending in 1965) was about 169,516 tons per year. About 10 pounds of DDT per year were included in that sediment load, according to Childress.

Shepard (1953) states that parts of Western Matagorda Bay have been deepening for the past 100 years while Lavaca Bay has been filling up with river sediment. The erosion is attributed by Shepard to tidal scour and the deposition is attributed to unloading of suspended sediment by the Lavaca River. Shepard states that Matagorda Bay has, in parts, deepened as much as 0.22 feet per 100 years while Lavaca Bay has shoaled up to 0.46 feet per 100 years while Lavaca Bay has shoaled up to 0.46 feet per 100 years or 4,155 acre-feet per 100 years.

Because Lavaca Bay is in a depositional mode while the most tide-swept parts of Matagorda Bay are in an erosional mode, most of the DDT/PCB pollution should be expected in Lavaca Bay. And because the shipping channel from the Intracoastal Waterway north through Lavaca Bay acts as a flume in exchanging tidal waters between the Gulf and the bay areas (Holliday, this volume) the areas around the shipping channel are subject to a greater "pollution flux" than the bay waters in general. This statement is supported by the contour maps which show DDT and DDE "highs" which coincide with the channel.

Land-use in the Lavaca River drainage area and in the area around Lavaca and Matagorda Bays is important when considering the source and the availability of various chlorinated hydrocarbon pollutants. Cultivated crop-lands, for example, will receive substantially more biocides than uncultivated rangeland. Furthermore, cultivated land is more subject to erosion than grassland. The industrial land-use maps may provide data on point-sources of pollution - especially PCB pollution. Because no PCB's were detected in the samples from this study, industrial activity is not considered as a major DDT/PCB polluter to Lavaca/Matagorda Bay. Cultivated lands and non-cultivated lands are shown on Figure 5.

The depositional patterns of sediments may aid in locating pollution sinks and areas which may be relatively free pollutants. For example, muddy areas usually contain abundant clay minerals and organic detritus; therefore, they are potentially sinks or depocenters for absorbed DDT and PCB's. Sandy areas, on the other hand, are mainly current-swept, quartz-sandy zones which are highly oxygenated, biologically active and impoverished with respect to sedimentary organic matter. A simplified map of the sediments in the study area is shown in Figure 6.

The physical factors involved in DDT and PCB pollution have been mentioned briefly above. The main factor in this category is water movement. The ship channel through Lavaca Bay carries most of the tidal exchange between the bay and the Gulf. Therefore, the channel areas are subject to a greater pollution flux, but, they are also subject to a faster flushing rate than the surrounding bay areas. The report by Holliday (this volume) discussed the circulation patterns and flushing of the study area in some detail.

SUMMARY AND CONCLUSIONS

The Lavaca-Western Matagorda Bay area contains sediments with combined DDT-DDE values ranging from 2 to 64 ppb. PCB's were not detected in any of the 35 selected samples which were analyzed.

Sediments in Lavaca Bay are muddier than those in most of Matagorda Bay and the potential to retain sorbed po-lutants is therefore greatest in Lavaca Bay. The ship channel through Lavaca Bay acts as a flume for exchanging tidal water between the bay and the Gulf. DDT and DDE are more abundant around the ship channel than on the bay flats -

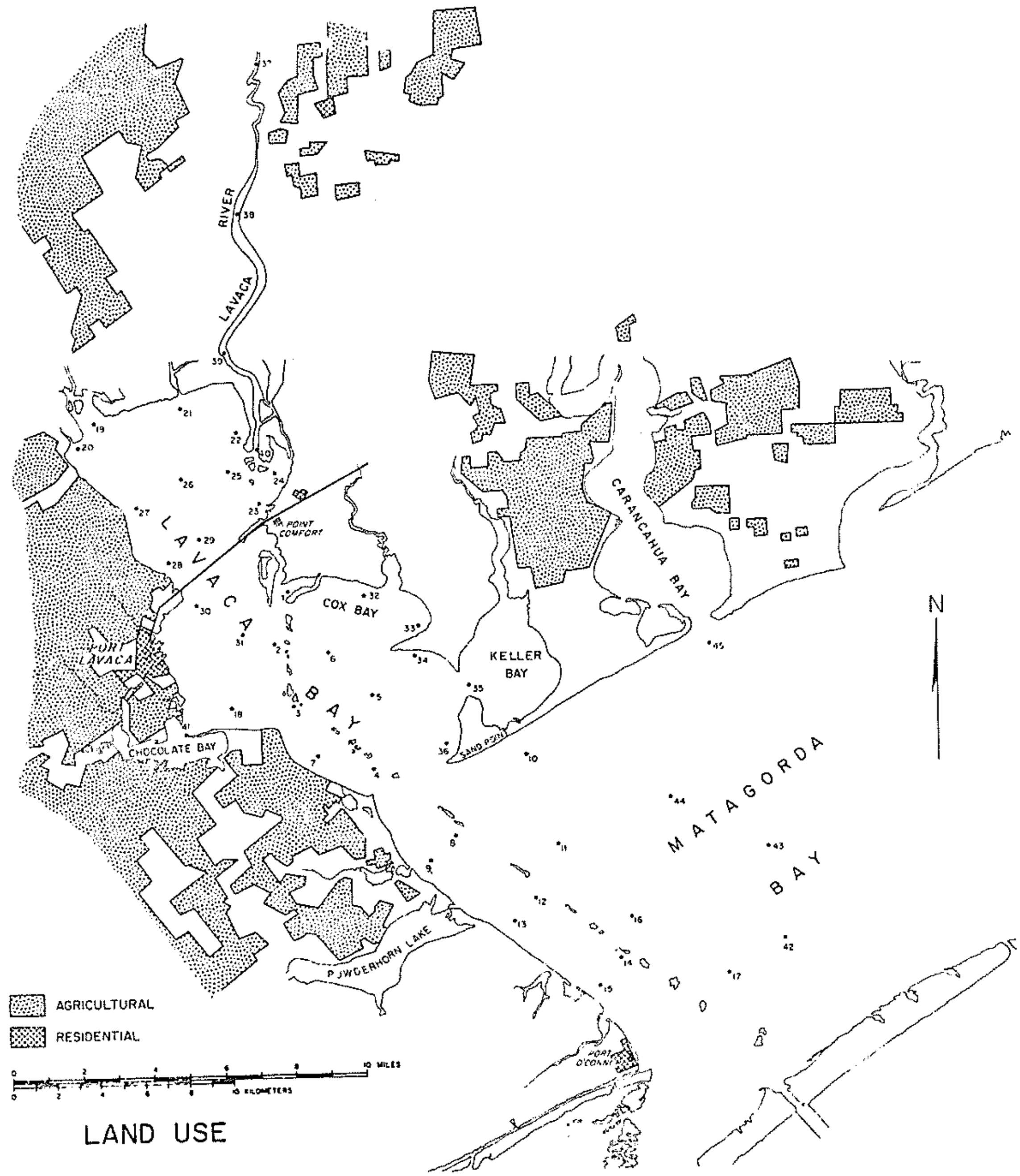


Figure 5.

Land use around the study area - greatly simplified. (After McGowan and others, BEG, Austin, Texas).

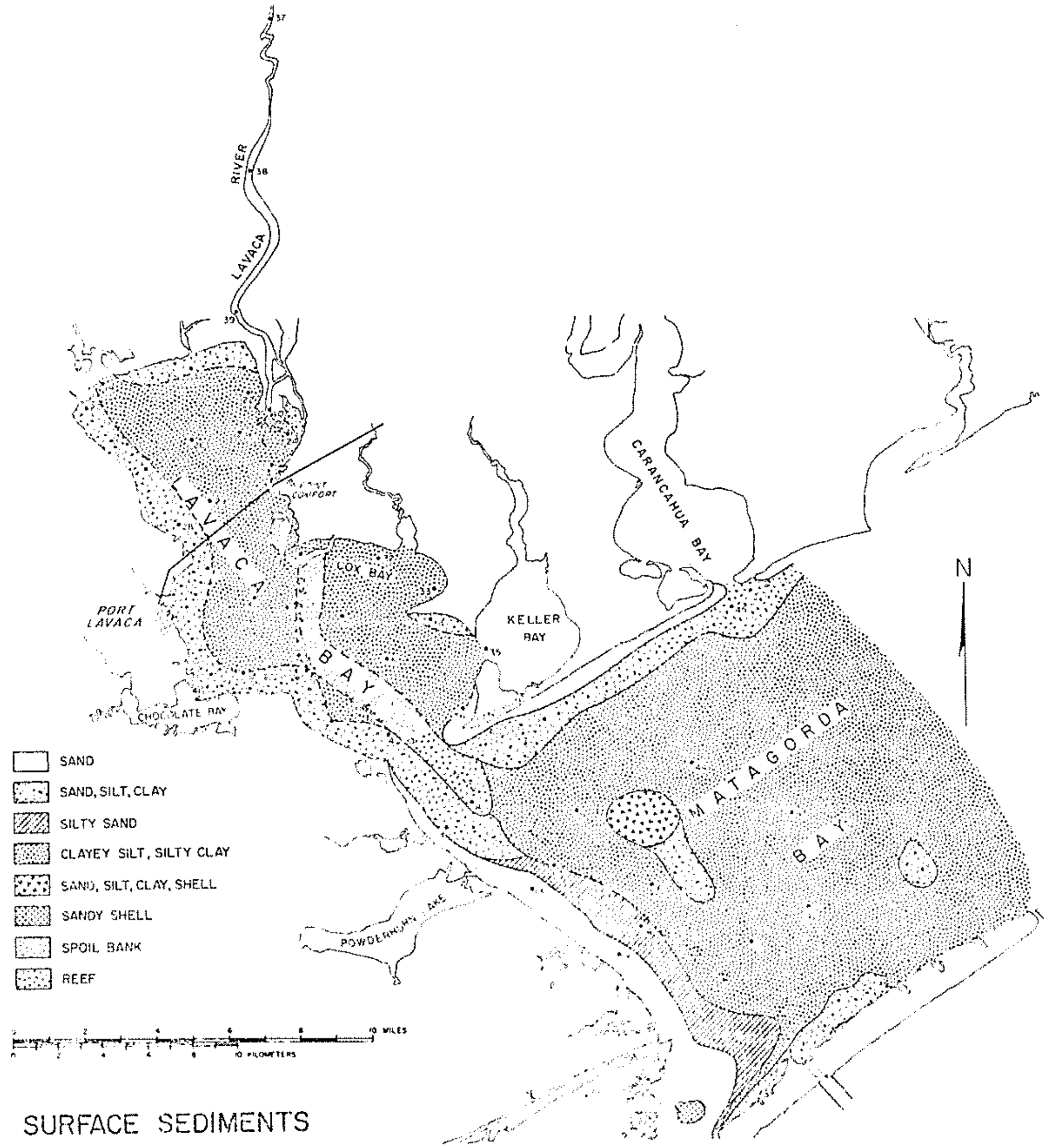


Figure 6.

Sedimentary patterns in the study area.
Data are from unpublished sources filed at Texas A&M
Depts. of Oceanography & Geology,
including Fagg, 1957.

apparently regardless of the kinds of sediments that make up the bay flats. It seems that the volume of pollutants in the channel area causes the sediments there to have a high charge of DDT/DDe as compared to the bay flats.

Organic carbon content of bay sediments (obtained from BEG data) did not correspond with the DDT or DDE values from Texas A&M's sediment samples. The lack of correspondence in these two classes of data is probably due to the fact that the different analyses were done on samples which were collected at different times, different places (station locations did not exactly coincide) and by different techniques. This writer has found that organic carbon and DDT/DDE values have high correlation coefficients when the analyses are done on splits from a single sediment sample.

The quantity of combined DDT/DDE in the Matagorda-Lavaca Bay area range between 2 and 64 ppb. A common expected DDT/DDE value in the Lavaca Bay area is in the range of 18 to 25 ppb. The common expected values for bay flats are lower - 10 to 15 ppb. These DDT/DDE values agree with DDT/DDE values in sediments from San Antonio Bay and in sediments from the Laguna Atascosa National Wildlife Refuge near Brownsville.

The study area has a DDT/DDE content similar to San Antonio Bay and the Laguna Atascosa National Wildlife Refuge and PCB's were not detected. The results of this report are useful in extending coastwide baseline values to the study area and if the area is managed with consideration given to the processes of pollution dispersal and retention, there should be no major additional threat from chlorinated hydrocarbons. It must be remembered that DDT (and some PCB's) may be very persistent; they are retained in the sedimentary substrata, and they are concentrated exponentially through the "food chain." A few parts per billion may be harmful to wildlife.

Ahr, W.M., 1972, The DDT Profile of Some South Texas Coastal-Zone Sediments, Texas A&M Environmental Quality Note EQN-05, 32 p.

Ahr, W.M., 1973, Long-lived Pollutants in Sediments From the Laguna Atascosa National Wildlife Refuge, Texas. Bull. Geol. Soc. America, v. 84, pp. 2511-2516.

Bader, R.G., et al, 1960, Recovery of Dissolved Organic Matter in Sea-Water and Organic Sorption by Particulate Material, Geochim. et Cosmochim. Acta, v. 19, p. 236-243.

Fagg, D.B., 1957, The Recent Marine Sediments and Pleistocene Surface of Matagorda Bay, Texas, G.C.A.G.S. Trans., v. 7, p. 119-133 (Texas A&m Masters Thesis).

Harriss, R.C., 1971, Ecological Implications of Mercury Pollution in Aquatic Systems, Biol. Conservation, v. 3, p. 279-283.

Huang, Ju-Chang, 1971, Effect of Selected Factors on Pesticide Sorption and Desorption in the Aquatic System: Water Pollution Control, Fed., Jour., v. 43, p. 1739-1748.

Huang, JuChang, and Cheng-San Liao, 1970, Adsorption of Pesticides by Clay Minerals, Jour. Sanitary Eng. Div., Am. Soc. Civil Engineers Proc., v. 96, SA 5, p. 1057-1078.

Nash, R.G., and Woolson, E.A., 1967, Persistence of Chlorinated Hydrocarbon Insecticides in Soils, Science, v. 157, p. 576-577.

Shepard, F.P., 1953, Sedimentation Rates in Texas Bays, Amer. Assoc. Petrol. Geologists Bulletin, v. 37, p. 1919-1934.

SKELETAL REMAINS OF SOME BENTHIC MICROORGANISMS AS ENVIRONMENTAL INDICATORS IN MATAGORDA BAY, TEXAS

Harold W. Harry and Thomas G. Littleton
Department of Biology

INTRODUCTION

The present study was undertaken to determine the extent to which the skeletal remains of benthic organisms in the superficial substrate of Matagorda Bay, Texas, may be useful in determining environmental conditions within the bay. Several studies have been made on the foraminifera of the bays of Louisiana and Texas, notably those of Lehmann (1957), Bran (1969), Wantland (1969), Waldron (1956, 1963), and Phlegler (1956, 1960). The ostracods of the bays of this area have been reported by Swain (1955) for San Antonio Bay; Engle and Swain (1967) for Mesquite, Aransas and Copano Bays; and by King and Kornicker (1970) for Copano and Redfish Bays, and the upper part of Laguna Madre. The studies on the molluscs of the bay complexes along the Texas coast are fewer, less detailed, and generally based on material larger than 1 mm in size. Especially useful are those of Ladd (1951), Parker (1959, 1960) and Andrews (1971).

No studies considered all those groups of organisms together (from the same set of samples) in order to determine the relative usefulness of the various groups in evaluating environmental conditions. Unfortunately, the correlation of faunal assemblages from the present set of samples with extensive sediment analyses has not been possible. A study of the sediments of Matagorda Bay was made by Fagg (1957).

We thank Dr. J.H. McGowan and Mr. Jim Burn, of the Texas Bureau of Economic Geology, for the Matagorda Bay sediment samples and for their helpful discussions.

Methods

Sediment samples were collected from Matagorda Bay by the Bureau of Economic Geology. A Peterson grab sampler was used, and field work was done during the latter part of 1972. Field samples were stored in labeled plastic bags. When the samples reached Texas A&M, they were still moist. Aliquots of 30 to 100 ml volume were taken from the field samples, placed in labeled, pint-sized cardboard cartons and air dried before analysis. Each aliquot was transferred to a small beaker, weighed, and covered with a 1 percent solution of a commercial detergent, Calgonite, for a few hours to several days in order to disperse any agglutinated lumps. Each sample was then fractionated by washing with a spray of tap water, using a series of standard sediment sieves arranged in decreasing mesh size in the following order: 1.0, 0.5, 0.25, 0.125 and 0.063 mm.

Sediments finer than 0.06 mm were discarded. The other fractions were transferred to 50 ml beakers, dried in an oven at 100^{o} C for a few hours and then transferred to small plastic vials. The composition of each fraction (sand, shell, organic material) was appraised by gross observation. The fractions were weighed, and the weights converted to percent of the retained part, that is, exclusive of that which passed the 0.06 mm sieve.

Each fraction was examined with a stereoscopic microscope. A size 00 sable hair artist's brush, moistened in a weak solution of gum tragacanth, was used to pick representatives of each species of microorganism from the sediment. The selected specimens were transferred to micro-paleontological slides. Specimens of molluscs larger than 1 mm in size were stored in small glass vials.

The specimens were arranged on the slides according to species, identified, and species lists prepared for each station. The nomenclature of the molluscs is generally that of Andrews (1971); the names of the ostracods follows Swain (1955) as modified by Engle and Swain (1967) and King and Kornicker (1970). The nomenclature of the foraminifera is in general that of Lehmann (1957).

RESULTS

The samples selected for analysis are from four regions of the Matagorda Bay complex, which are delineated in the following manner, and located on Figure 1.

1. East Matagorda Bay (samples EMB4-EMB35). Near the north, west and south shore and center bay, at the west end of east Matagorda Bay. This is a lagoonal part of the bay complex, completely separated from the rest of the bay by the Colorado River delta, except for the intracoastal canal.
2. East end of Matagorda Bay, in the lagoonal part of the bay complex, just west of the Colorado River delta (samples MB3-MB33). Samples are from nearshore areas in the north, south and delta areas as well as in the central bay area.
3. The lower, estuarine part of the Matagorda Bay complex, immediately east of the ship channel (samples MB34-MB44). None of these samples are from nearshore.
4. The lower half of the upper estuarine part of the Matagorda Bay complex, named Lavaca Bay on the map (samples LF5-LV5). All samples were taken east of the Matagorda ship channel, and away from shore, except LV5.

The dry weight of aliquot samples before screening averaged 31 grams, and ranged from 12 to 62 grams. The summation of weights of fractions retained after sieving each aliquot, subtracted from the total weight of the dry, original aliquot, indicates the discarded fraction, or mud. This is expressed as percent mud in Table 1. Estimated mud content ranged from 18 to 99%. Only 5 samples had less than 50% mud, while 19 samples had more than 90%.

For each aliquot sample the percentage of each fraction retained, with total retained being 100%, was converted to a whole number as follows: 0-9% is 0, 10-19% is 1, 20-29% is 2, etc. Writing these figures to form a five-digit number provides a simple expression of the relative amount of each fraction within a sample, exclusive of mud (Table 1, Retained fraction proportion). The digits should add up to 9 or 10, depending on whether the zeros represent no fraction, or an amount less than 10%. The digits are arranged in decreasing series, with the fraction retained by the largest mesh size being represented by the digit on the left.

The fractions retained on the two largest mesh screens (1.0 and 0.5 mm) consisted of shell fragments with variable but often large proportions of quartz sand grains. The fractions retained on the fourth and fifth size screens, or 0.1 and 0.06 mm mesh, consisted almost entirely of quartz sand grains with a minute component of shell fragments.

The recognizable remains of organisms found can be grouped into the following headings:

1. Bivalve and scaphopod molluscs
2. Gastropod molluscs
3. Foraminifera
4. Ostracoda
5. Miscellaneous (fish vertebrae, agglutinated (fecal) pellets; fish otoliths, barnacle plates, encrusting bryozoa), and a few

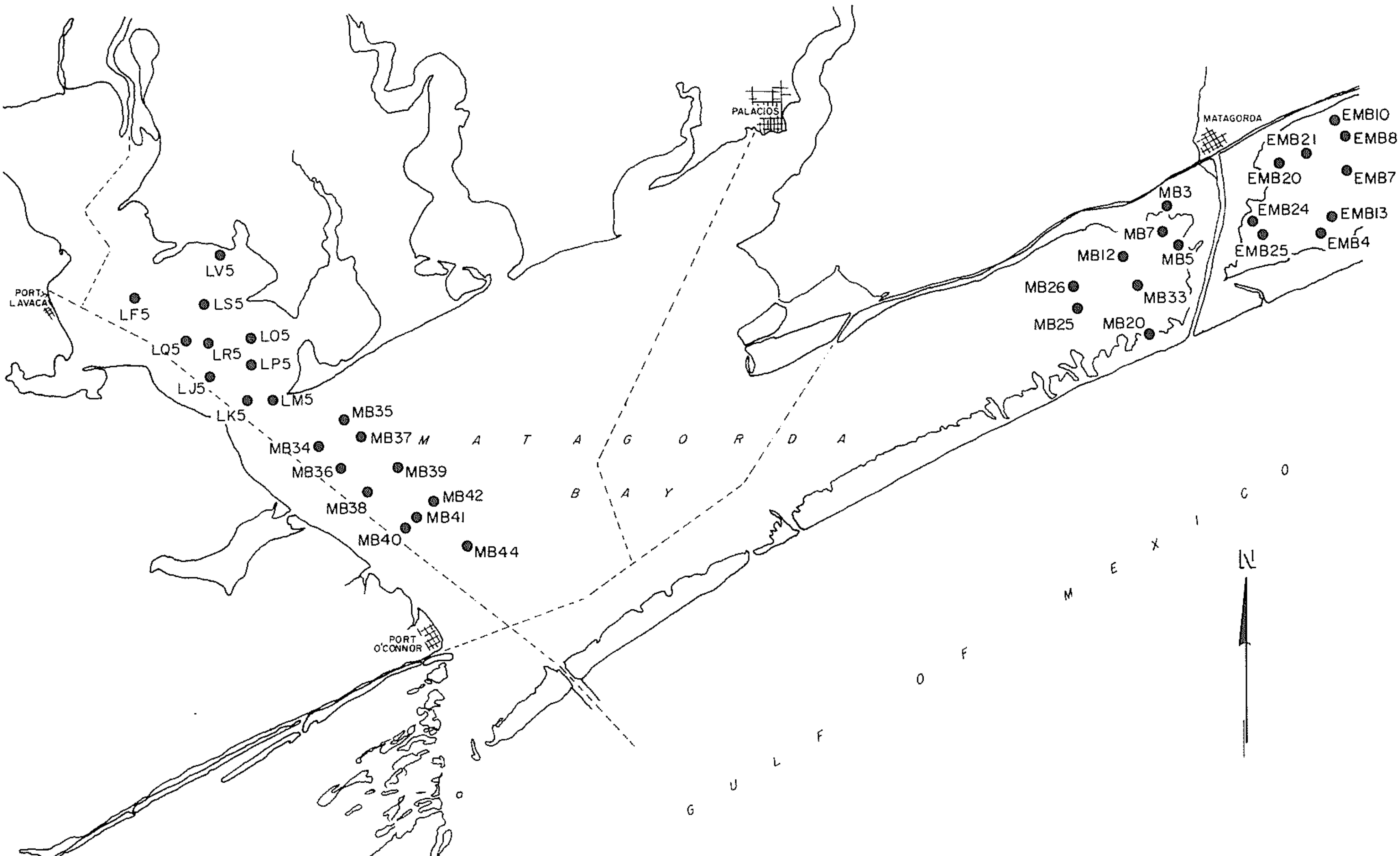

MATAGORDA
PALACIOS
PORT LAVACA
PORT O'CONNOR
M A T A G O R D A
B A Y
G U L F O F M E X I C O
N
EMB10
EMB8
EMB21
EMB20
EMB7
EMB24
EMB13
EMB25
EMB4
MB3
MB7
MB12
MB5
MB26
MB33
MB25
MB20
LV5
LF5
LS5
LQ5
LR5
LO5
LP5
LJ5
LM5
LK5
MB35
MB37
MB34
MB36
MB39
MB38
MB42
MB41
MB40
MB44

Figure 1

unidentified objects.

Most of the recognizable molluscs were found in the 0.5 mm fraction, with a few from fractions of 1.0 mm mesh screens, and more rarely in the fractions of 0.25 or 0.1 mm mesh. Most foraminifera and ostracods were found in the fractions retained on the screen of 0.25 mm mesh, with a few specimens only in the 0.1 mm fractions. Usually the 0.06 mm fractions did not yield enough specimens to merit picking. The miscellaneous remains occurred in all 4 fractions of larger particle size, but these remains were too rare to allow any conclusions to be drawn about their environmental significance.

The general organism abundance, regardless of taxonomic diversity within each of the four major groups, is shown in the four columns on the right side of Table 1. Abundance was estimated, since the method of sampling and analysis did not warrant exact counts of specimens.

Generally, a sample rich in specimens of one group was rich in specimens of the other groups also. There seemed to be little correlation between general abundance of microorganisms and substrate type, and there was no consistent correlation between sample size and abundance of total organisms.

The identifiable mollusca were less abundant in the samples than were species of foraminifera and ostracods. Protoconchs and fragments of larger species were found, as well as complete specimens of smaller species, often much abraided. Lists of molluscan species are presented in Tables II and III. The identification of all species of molluscs, especially when they were represented only by protoconchs, is tentative. It was often impossible to distinguish between certain species, and even some closely related genera, particularly of the following groups:

1. Ostrea equestris, Crassostrea virginica and Anomia simplex.

TABLE I

Station	Gm Wt. dry sample	% mud	Retained Fraction Proportion	Bivalves	Gastrop.	Forams.	ostrac.
MB3	62	66	00045	R	R	A	A
MB5	23	60	20123	C	R	A	A
MB7	54	80	30023	C	C	A	A
MB12	25	30	35100	A	A	A	A
MB20	40	75	00073	O	O	A	R
MB25	61	66	00073	A	A	C	C
MB26	50	80	00053	A	A	A	C
MB33	43	95	00135	O	O	A	C
MB34	18	33	11125	C	R	A	A
MB35	15	95	00145	O	O	C	C
MB36	20	95	00135	C	R	C	C
MB37	14	95	11125	R	R	A	C
MB38	28	95	00225	O	O	R	R
MB39	33	95	00135	R	O	A	C
MB40	28	95	00225	R	O	C	C
MB41	35	90	22222	R	R	A	A
MB42	15	95	22222	R	R	A	C
MB44	13	95	00027	R	O	R	R
EMB4	39	18	00072	A	C	A	C
EMB7	39	75	10026	A	A	A	C
EMB8	22	95	11125	C	C	A	A
EMB10	37	75	21115	A	A	A	C
EMB13	44	90	21123	A	A	A	C
EMB20	44	75	11125	A	A	A	R
EMB21	31	90	21124	A	A	A	C
EMB24	36	90	52111	A	A	A	C
EMB25	21	99	00144	R	R	A	R
LF5	17	99	22222	C	R	A	R
LJ5	26	95	00035	O	O	A	R
LK5	18	66	00144	C	C	A	C
LM5	50	33	11152	A	A	A	A
LO5	29	30	10044	R	A	A	A
LP5	19	99	11125	O	R	C	C
LQ5	12	99	00045	O	R	C	R
LR5	19	99	11134	R	R	C	C
LS5	20	99	11125	R	R	A	R
LV5	49	60	00135	R	R	A	A

Station catalogue and composition of substrate faunal remains. In the four columns on the right, O= none, R= rare, C= common, A= abundant. The figures in the column labled "Retained fraction proportion" are explained in the text.

TABLE II

Species	EMB4-EMB25	MB3-MB33	LF5-LV5	MB34-MB44
Retusa canaliculata	x	x	x	x
Actaeon punctostriatus		x	x	
Odostomia seminuda		x		
Odostomia teres		x	x	x
Odostomia dux	x			
Odostomia laevigata	x			
Odostomia impressa	x			
Turbonilla interrupta	x	x	x	
Turbonilla incisa				x
Turbonilla sp. F.		x	x	
Littorina irrorata		x		
Cerithium variablile			x	
Vermicularia fargoi	x	x		
Cochliolepis parasitica			x	
Vitrinellidae (3sp.)	x	x		
Caecum pulchellum	x	x	x	x
Caecum glabrum	x	x	x	
Naticidae	x			
Nassarius acutus			x	
Mangilia sp.			x	
Mitrella lunata		x		
Anachis avara		x		
Crepidula plana		x		
Trifora sp.		x		
Seila adamsi		x		

Gastropods, indicating the station groups in which they were found.

TABLE III

Species	EMB4-EMB25	MB3-MB33	LF5-LV5	MB34-MB44
Bivalves:				
Nuculana acuta	x	x		
Nuculana concentrica	x	x	x	
Ischadium recurvus	x		x	x
Arca transversa	x	x		
Crassostrea virginica	x	x	x	x
Ostrea equestris	x	x	x	
Anomia simplex	x			
Crassinella lunulata		x		x
Lucina amianthus			x	
Leptonid, indet.			x	
Aligena texasiena		x	x	
Mysella planulata	x	x	x	
Mulinia lateralis (and Rangia?)	x	x	x	x
Anomalocardia cuneimeris	x			
Chione (2 sp.)	x			
Cyclinella tenuis			x	
Mercenaria mercenaria		x		
Petricola pholadiformis			x	
Tagelus divisus		x		
Macoma mitchelli		x	x	
Tellina sp (several?)	x			
Abra aequalie			x	
Cumingia tellinoides			x	
Semele proficua			x	
Pandora trilineata		x		
Cardium mortoni	x			
Scaphopods:				
Dentalium texasianum	x			

Bivalves and scaphopods, with station groups in which they were found.

2. *Mulinia lateralis*, *Rangia cuneata* and *R. flexuosa*. The presence of both species of Rangia was very doubtful.
3. *Nuculana concentrica* and *N. acuta*. Small specimens of both species seemed to occur, but only the former was certainly represented by adult size specimens.
4. Tellinidae (several species were present).
5. Veneridae (several species were present).

Similar problems were encountered in identifying the gastropods. Molluscs were rare or absent in many samples of the size used in the present study; they would scarcely be useful in determining environmental conditions by following the methods used in this investigation.

Foraminifera were present at all stations, and usually abundant. They were rare at only two stations. Present at nearly every station, and always abundant among the formainiferal species, were *Rotalia beccarii* (*Ammonia* and *Streblus* in much of the recent literature) and *Elphidium gunteri* and variations. Next in abundance, but relatively infrequent, were one to three species of Miliolidae. These were represented by only one or two specimens. Many others of the 71 species of foraminifera found in Matagorda Bay by Lehmann (1957) were found in these samples, but they were infrequent, and represented by few specimens. Arenaceous species were especially uncommon. No list of species of the present samples has been prepared.

Some ostracods were present in all samples examined. They were never as common as the foraminifera but were usually more common than the mollusca. Most of the 56 species recorded from adjacent bays by Swain (1955), Engle and Swain (1967), and King and Kornicker (1970), were found. Unlike the foraminifera, the assemblages of ostracod species varied greatly from station to station. The published reports also found this pattern of abundance.

Swain (1955) and Engle and Swain (1967) provided lists of species which were typical of several contrasting environmental types which they could recognize within the bay complexes. These environmental types, or facies, as they termed them were named on the basis of physiographic and biotic characteristics as explained in Parker (1959). King and Kornicker (1970) analyzed living ostracods from a few selected stations in bays farther down the coast (Copano and Redfish bays and Upper Laguna Madre). They defined assemblages which were named according to the two most abundant ostracod genera in them. Three such assemblages were found in their studies. Examination of samples in the present study indicated that at least six assemblages can be recognized, including the three proposed by King and Kornicker. Two of the three additional assemblages are based on species not found by King and Kornicker. Those species (3 of the genus Candona, and Loxoconcha australis), were found by Engle and Swain, however, in Aransas and San Antonio bays.

The six assemblages recognized from the present study, with the stations where they occurred are as follows:

1. Candona sp. and Cyprideis sp. Perissocytheridea brachyformis and Cytherura johnsoni commonly present.
   MB3, MB5, MB7, LV5, EMB7, EMB13, EMB21.
2. Perissocytheridea johnsoni-Cytherura sp.
   MB12, MB26, MB33, MB34, MB38, MB39?, MB40, LP5, LR5.
   Recognized by King and Kornicker.
3. Aurila sp. - Loxoconcha purisubrhomboidea.
   MB36.

   Recognized by King and Kornicker.

4. Loxoconcha australis-Perissocytheridea brachyformis.

   MB41, MB42, LK5.

5. Sparce total population-Cytherura sp.

   MB44

   Recognized by King and Kornicker.

6. Haplocytheridea bradyi-Perissocytheridea brachyformis-Cyprideis sp.

   LM5, LO5, EMB4, EMB8, EMB10.

Species not included in the above list had too few specimens of any one species to designate dominants.

Candona lactea and C. obtusa were well represented at those stations nearer shore, in coves, and along delta fronts. Whether this represents a preference for lower salinity, or an ability to tolerate the greater turbidity of shallower waters cannot be determined with certainty. That these species were not found by King and Kornicker may be the result of their having selected their stations to determine seasonal abundance and other ecological factors, rather than to provide an exhaustive survey of the ostracods of their area. There is no obvious correlation of the other assemblages with known environmental factors, which in this study are chiefly inferred from the location of the samples within the bay complex. Collectively they form a contrast to the Candona-Cyprideis assemblage.

Swain (1955) has published distribution maps of various species of ostracods in San Antonio bay. Most species can be designated as upper bay (i.e., lower average salinity) and lower bay (i.e., higher average salinity), buth there are enough exceptions for each common species to preclude using most species as indicators of environmental conditions. The distribution of the species of the present study agree generally with the distributions as reported by Swain.

Discussion

In general, ostracods are the most useful benthic microfauna with which to delineate bay environments on the basis of their frequency of occurrence and variation in assemblage at different bay localities. This conclusion obtains even without precise quantitative sampling and analysis of the total population and differentiation of living and dead specimens. Such procedures are too time-consuming to be practical. In the above cited studies on ostracods, it is generally concluded that dead specimens are fairly indicative of the living population at a given station. The few individuals which occur in habitats other than those in which they are abundant may be examples of the natural scatter of species into areas which are suboptimal, often to the extent that the species cannot establish itself in those habitats on a permanent basis. Unfortunately, not enough data on ostracods of the Texas coast are available to detect such cases, but a good beginning has been made by King and Kornicker, who cite a few additional studies on the biology of individual species.

The occasional occurrence of living and dead molluscs in habitats other than those in which they are established is important in faunistic studies, as was noted in unpublished studies on the mollusca of Galveston bay, done by the senior author. Many of the molluscs of the present study may be exploratory specimens, which have managed to invade habitats beyond the limits of tolerance for establishing permanent populations. An occasional specimen will nonetheless occur, usually a juvenile, in extraterritorial habitats.

There are enough differences in the general assemblage of molluscs of the samples of Matagorda Bay and Galveston Bay (unpublished studies,

H. Harry) to suggest that Matagorda Bay has a higher average salinity throughout the year than does Galveston Bay. The two species of Caecum, common in Matagorda Bay, are rare in the Galveston Bay complex. Nuculana was more abundant in Matagorda ay than in Galveston Bay; Abra was abundant in the latter but seemingly rare in Matagorda Bay.

Many of the gastropods and bivalves of the Matagorda bay samples belong to groups which seem to have a mutual relationship, amounting to semi-parasitism or commensalism, with other organisms. The species with which these relationships are established are usually limited, but unfortunately little is known about the species on the present lists.

The great abundance of the two species groups of foraminifera, Rotalia beccarii and Elphidium gunteri, at all stations, and the scarcity of other species, preclude the practical usefulness of foraminifera for differentiating habitat variation within the bays. The overwhelming abundance of these two species groups throughout the coastal bays (and excluding the marsh margins) is a general phenomenon along the northwestern Gulf of Mexico (Lehmann, 1957 and Wantland, 1969).

The uncommon occurrence of agglutinated foraminiferal tests (i.e., those made of substrate particles cemented together rather than a continuous layer of calcium carbonate secreted by the animal) in the samples of this study was unexpected and evidently constitutes a discrepancy from the results of other studies on the bays of the Gulf coast. It may have resulted from soaking the samples in detergent (Calgonite) before washing them. This may have dissolved the agglutinated tests. Those few which were found often crumbled when touched with a moist brush, in transferring them to a slide.

The species variation of Elphidium encountered in this study suggests that several of the two or more nominal species may be variations of one or a few species. Further studies on the biology of this species complex might resolve the problem. The interpretation of environmental factors inferred from the presence of the remains of organisms will be more precise when more is known about the life history of individual species, their variation, and the conditions under which their remains are degraded or preserved.

BIBLIOGRAPHY

Andrews, Jean, 1971, Sea Shells of the Texas Coast, University of Texas Press, Austin, 298 p.

Brann, B.C., 1969, Microfossils of the Trinity River Delta, pp 118-126 in Galveston Bay Geology, ed. by R.R. Lankford and J.J.W. Rodgers, Houston Geological Society Spec. Pub., 141 p.

Engle, P.L. and F.M. Swain, 1967, Environmental Relationships of Recent Ostracoda in Mesquite, Aransas and Copano Bays, Texas Gulf Coast, Trans. Gulf Coast Assn. Geol. Soc., 17:408-427.

Fagg, D.B., 1957, The Recent Marine Sediments and Pleistocene Surface of Matagorda Bay, Texas, Trans. Gulf Coast Assn. Geol. Soc., 7:119-133.

King, C.E. and L.S. Kornicker, 1970, Ostracoda in Texas Bays and Lagoons, Smithsonian Contrib. to Zool., No. 24, 92 p.

Ladd, H.S., 1951, Brackish Water and Marine Assemblages of the Texas Coast, Publ. Inst. of Marine Sci., Univ. of Texas 2(2): 125-163.

Lehmann, E.P., 1957, Statistical Study of Texas Gulf Coast Recent Foraminiferal Facies, Micropaleont, 3(4): 325-356.

Parker, R.H., 1959, Macro-Invertebrate Assemblages of Central Texas Coastal Bays and Laguna Madre, Bull. Amer. Assn. Petrol. Geol. 43(9): 2100-2166

Parker, R.H., 1960, Ecology and Distributional Patterns of Marine Macro-Invertebrates, Northern Gulf of Mexico, pp. 302-337, in Recent Sediments, Northwest Gulf of Mexico, ed. by F.P. Shepard et. al., Special Pub. Amer. Assoc. Petrol. Geol. Tulsa 394 p.

Phlegler, F.B., 1956, Significance of Living Foraminiferal Populations Along the Central Texas Coast, Cushman Found. Foram. Res. Contrib. 7(4): 106-151.

Phlegler, F.B., 1960, Sedimentary Patterns of Microfaunas in the Northern Gulf of Mexico, pp. 267-301, in Recent Sediments, Northwest Gulf of Mexico, ed. by F.P. Shepard et. al., Ed. Spec. Pub. Amer. Assoc. Petrol. Geol., Tulsa, 394 p.

Swain, F.M., 1955, Ostracoda of San Antonio Bay, Texas, Jour. Paleont. 29(4): 561-646.

Waldron, R.P., 1956, Ecology of Foraminifera of the Buras-Scofield Bayou Region, Southeast Louisiana, Gulf Coast Assoc. Geol. Soc. Trans. 6:131-152.

Waldron, R.P., 1963, A Seasonal Ecological Study of Foraminifera From Timbalier Bay, Louisiana, Gulf Res. Reports 1(4): 132-186.

Wantland, K.F., 1969, Distribution of Modern Brackish Water Foraminifera in Trinity Bay, in Galveston Bay Geology, ed. by R.R. Lankford and J.J.W. Rogers, Houston Geological Soc. Spec. Pub. 141 p.

ECONOMIC ANALYSIS OF THE MATAGORDA BAY REGION

Larry Vetter and John Miloy
Industrial Economics Research Division
Texas Engineering Experiment Station

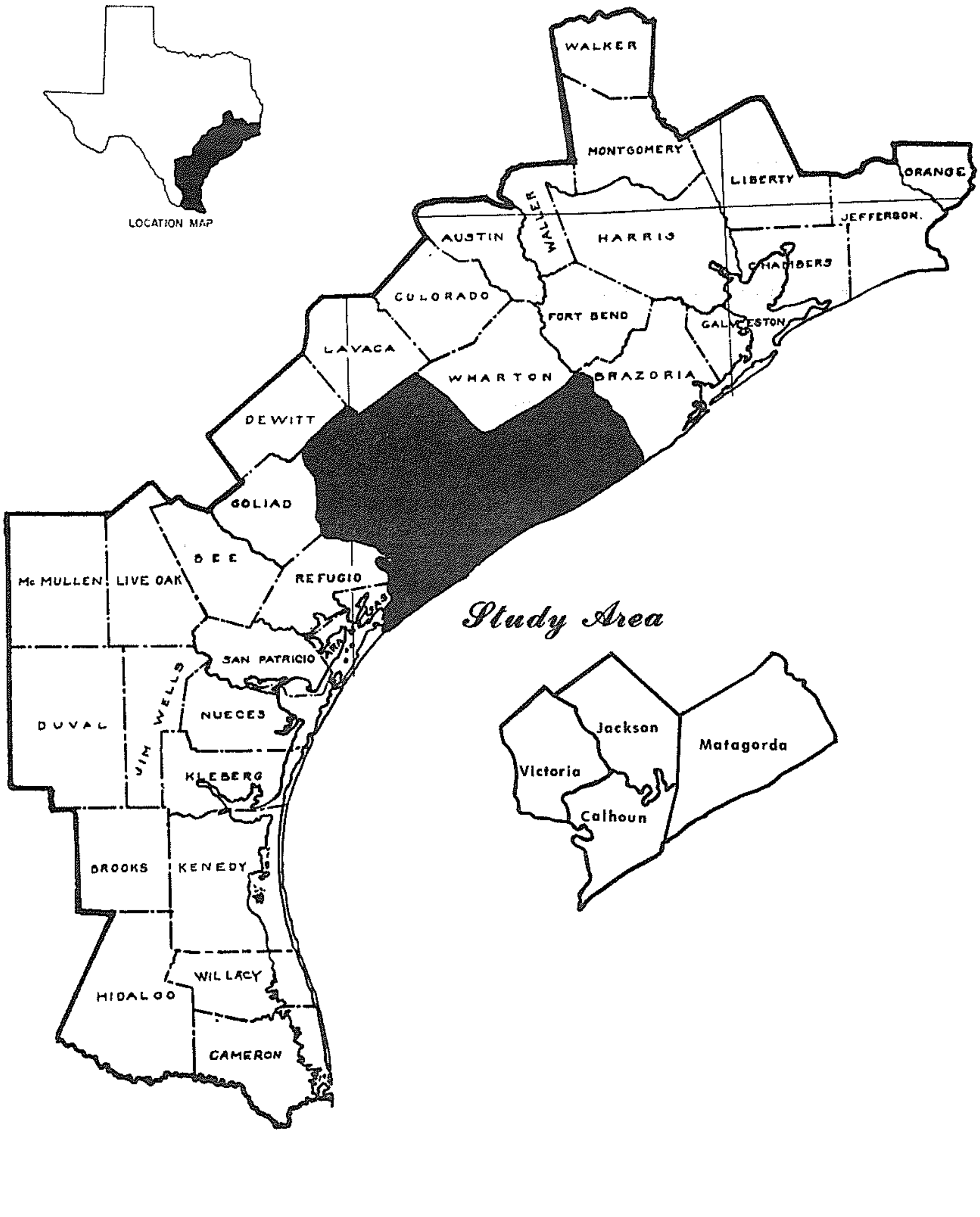
INTRODUCTION

The Texas coastal zone has recently experienced the greatest economic growth rate in the state. This report examines the current economic strengths and activities by type of economic development in the four county region surrounding Matagorda Bay. This study area is comprised of Calhoun, Jackson, Matagorda, and Victoria Counties and is located in the central part of the Texas coast (Figure 1).

During the 1950's, the study area showed a rapid rise in population, which was expected to continue. However, the population increase during the 1960's leveled and it appears that population projections made during the 1960's will not be realized. Indeed, it will be difficult for Jackson County to reverse its downward trend.

Primary economic sector activities will decrease in terms of both earnings and employment. Secondary sectors should show local variations, but the four county area may have reached its peak earnings and employment power. Tertiary sector enterprises should find room for expansion.

The economic impact of the Palmetto Bend Dam and Reservoir has not been included in this report. Another factor that was not considered in this report is the impact of locating facilities such as offshore ports or Nuplex facilities. Of these, the latter would appear to be much more significant to the study area.



COASTAL ZONE AND STUDY AREA

FIGURE 1

In the course of this study, questionnaires were sent to the leading employers in the region. Thirty-six percent answered. The results were not conclusive, but the data have helped to substantiate, at points, certain trends.

Acknowledgments

Those individual firms, units of government, and Chambers of Commerce who provided information and other assistance in the development of the study are gratefully acknowledged.

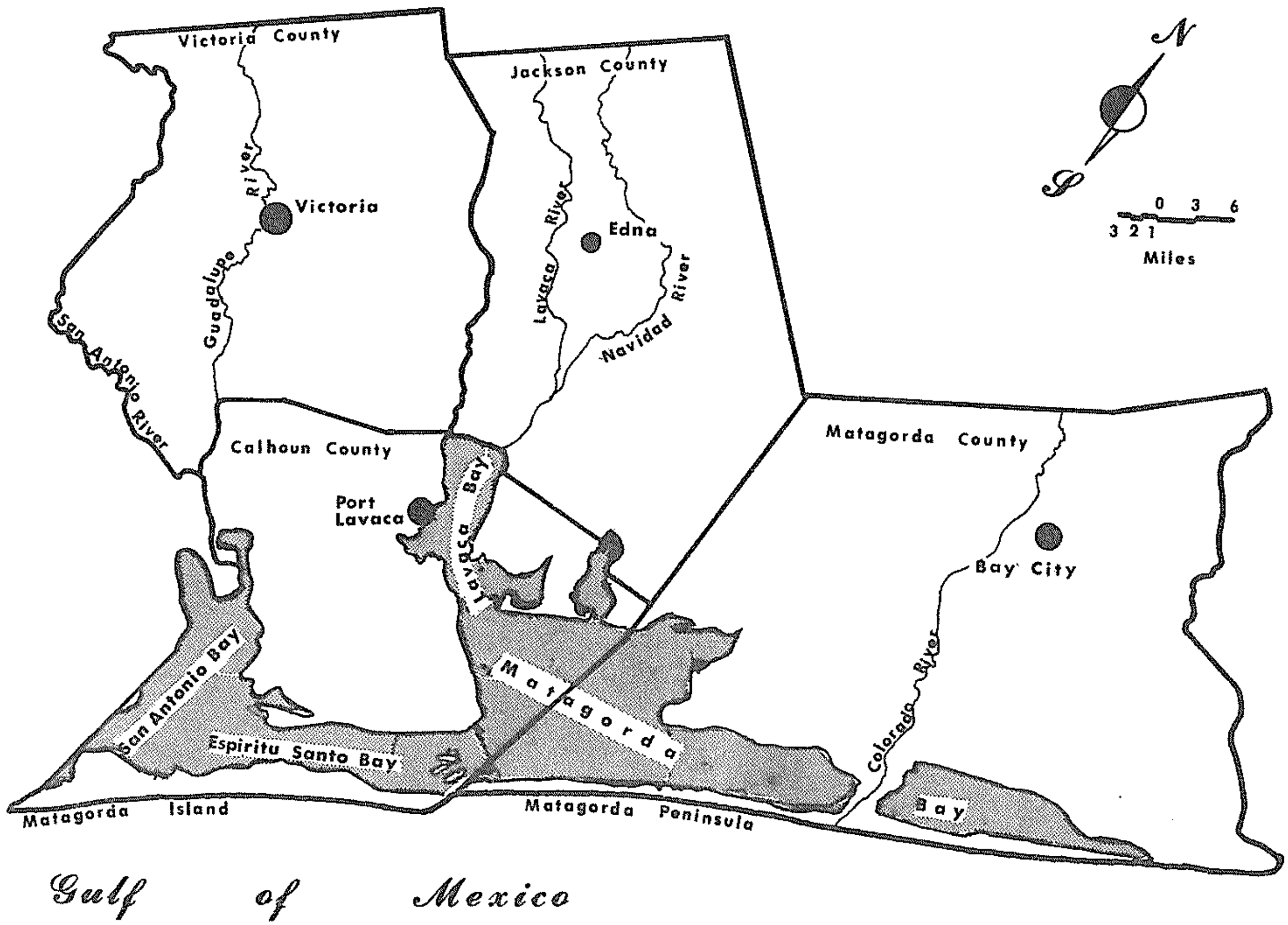
Location of the Study Area

The Matagorda Bay-Estuarine complex lies in the central sector of the Texas Gulf Coast, approximately 80 miles northeast of Corpus Christi and 120 miles southwest of Houston. Within this study area there are four counties as shown in Figure 2 and listed below:

1. Matagorda: County seat -- Bay City
2. Jackson: County seat -- Edna
3. Victoria: County seat -- Victoria
4. Calhoun: County seat -- Port Lavaca

General Population Characteristics

Table 1 indicates population by county and county seat in this four-county region for the census years 1940 through 1970. From this table and Figures 3 and 4, several population trends can be ascertained. Total population for the area has steadily increased since 1940 by 83 percent. The 1950's showed gains of 37 percent but the 1960's showed only



STUDY AREA

FIGURE 2

10 percent gains. Calhoun and Victoria Counties show the greatest increases since 1940 with Calhoun at 202 percent and Victoria at 126 percent; however, Calhoun more abruptly leveled off in the 1960's with a seven percent increase, as Victoria rose with 15 percent. Jackson County in the 30-year interval increased by 11 percent, but lost population in the past decade. Matagorda, at a fairly steady pace, has had a 39 percent population increase since 1940.

While total county population has increased by 83 percent over the 1940 level, the population of the four county seats has risen by 200 percent. The peak growth period was the 1950's, where a 67 percent increase took place. While total area population rose by only 10 percent in the past decade, the county seat population increased at a rate of 18 percent. The county seats of Port Lavaca and Victoria had the greatest 30-year increases. Port Lavaca underwent a 407 percent rise in population, and Victoria, 258 percent, although they respectively dropped to more modest 18 percent and 25 percent increases during the 1960's.

Three major factors influence these statistics: 1) the significant trend toward urbanization, 2) the ramifications of the prominent deceleration of the growth rate during the past decade, and 3) population growth centers contrasted with static or declining populations.

MINERAL RESOURCES

The total value of Texas minerals over the period 1969-1971 was as follows:

1969 - $5,769,970.000
1970 - $6,341,761.000
1971 - $6,639,000.000

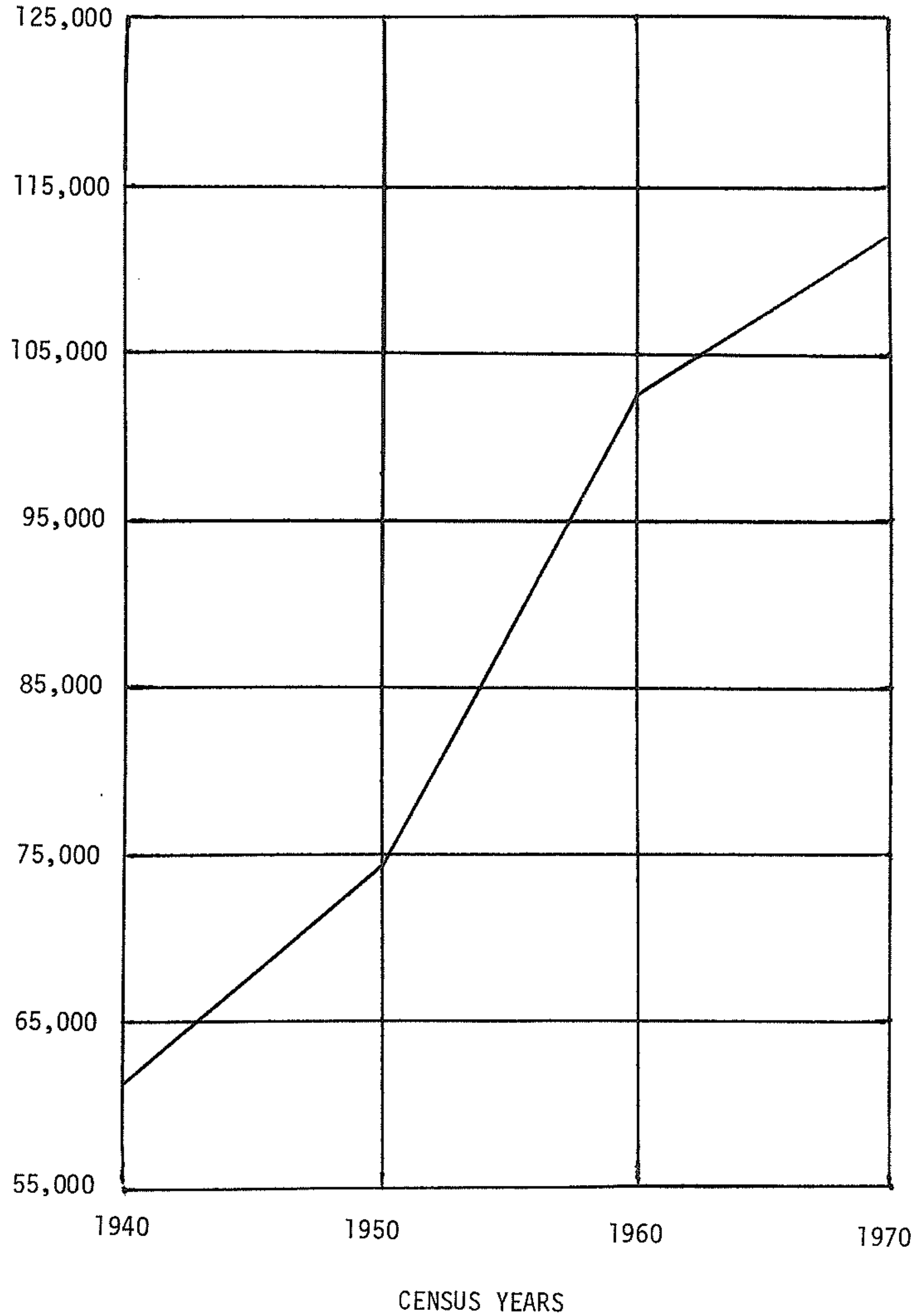
TABLE 1

POPULATION TRENDS IN THE STUDY AREA
1940-1970

COUNTY	1940	1950	1960	1970
CALHOUN	5,911	9,222	16,592	17,831
JACKSON	11,720	12,916	14,040	12,975
MATAGORDA	20,066	21,559	25,744	27,913
VICTORIA	23,741	31,241	46,475	53,766
	61,438	74,938	102,851	112,485

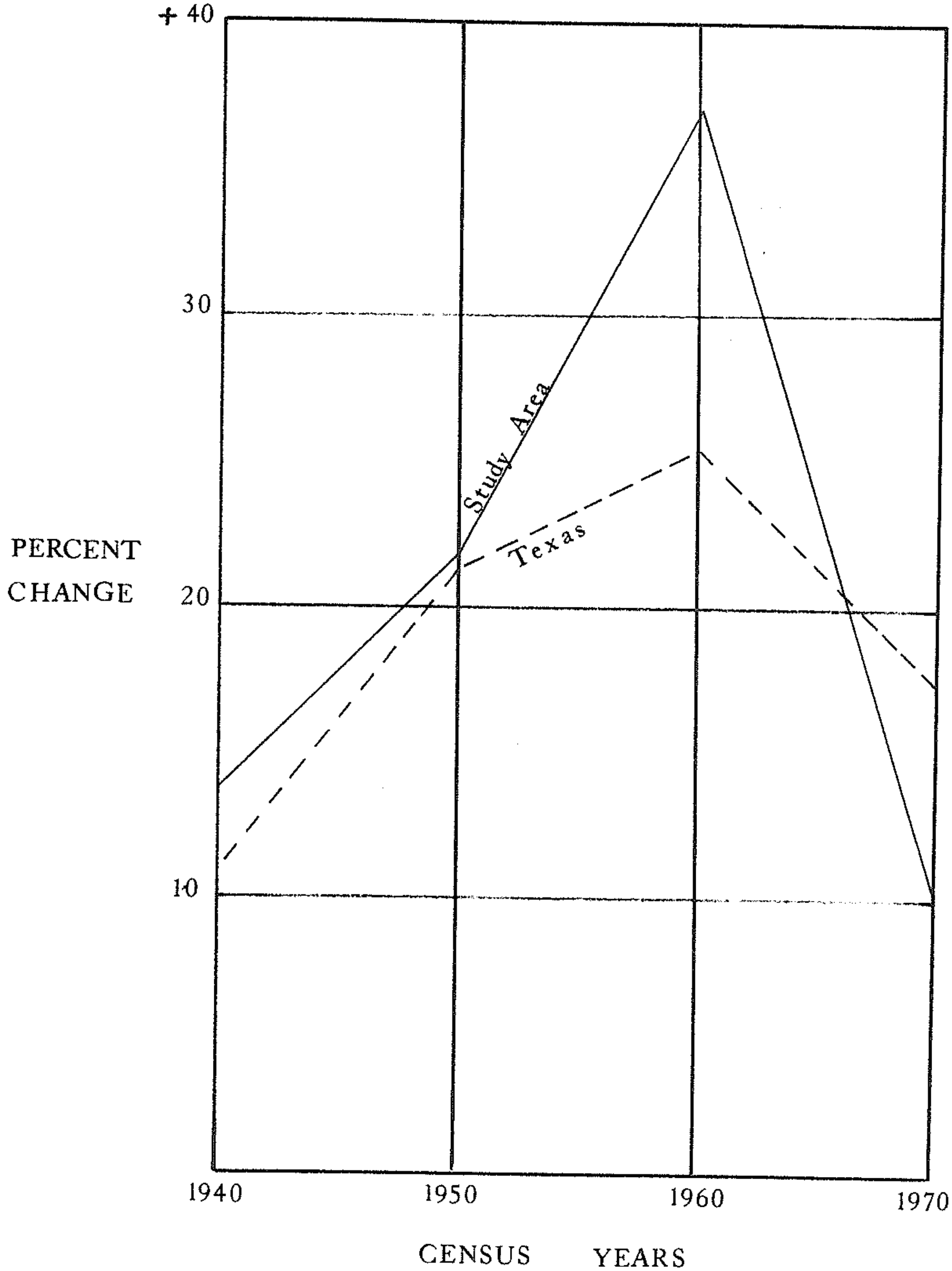
COUNTY SEAT	1940	1950	1960	1970
PORT LAVACA	2,069	5,599	8,864	10,491
EDNA	2,724	3,845	5,038	5,332
BAY CITY	6,594	9,427	11,656	11,733
VICTORIA	11,566	16,126	33,047	41,349
	22,953	34,997	58,605	68,905

SOURCE: Texas Almanac, 1972-1973 Edition, A. H. Belo Corporation, Dallas, Texas



ABSOLUTE POPULATION INCREASE FOR THE STUDY AREA

FIGURE 3



POPULATION TRENDS IN TEXAS AND THE STUDY AREA: 1940 - 1970 (PERCENT CHANGE)

FIGURE 4

This last total was a record high and with it Texas led the nation in total mineral values. The coastal zone of Texas produced approximately one-third of this or some $2.2 billion. The production of crude oil and natural gas makes up the majority of this value. Table 2 indicates the oil and gas production by county in the study area from 1963 to 1971. As can be seen from this table, Jackson County is by far the leading producer of crude oil, while Matagorda County is more than double any other county in natural gas production. In total value, Jackson County shows about twice the value of Matagorda. Victoria and Calhoun Counties show the least production of either mineral. Table 3 shows the comparative ranking of these four counties among all Texas counties in total oil and gas value. One possible note to the latest trends is that there has been a recent decline in oil and gas values in the area counties. For those counties and cities that do not have a broad tax base, there could be a significant and meaningful loss in tax revenue due to the diminished value of oil and gas production.

In order to analyze the mineral resources of the study area, a brief economic view of the overall Texas Coastal Zone is included below. The information is based mainly on an interim report by the United States Department of Agriculture in cooperation with the Texas Water Development Board, the Texas State Soil and Water Conservation Board, and the Interagency Natural Resources Council, entitled <u>Texas Coastal Basins</u>, January, 1972.

Petroleum and natural gas are the most important coastal zone mineral resources. Figures 5 through 8 show the locations of many of the oil and gas fields, which cover some 3,300,000 acres of the coastal zone (about 15 percent of the total). Other economically important minerals in this zone are:

TABLE 2

OIL AND GAS PRODUCTION BY COUNTY

CALHOUN COUNTY

	CRUDE OIL BARRELS (000)	CRUDE OIL DOLLAR VALUE (000)	NATURAL GAS MCF* (000)	NATURAL GAS DOLLAR VALUE (000)	TOTAL OIL & GAS DOLLAR VALUE (000)
1963	1,799	$ 5,343	100,531	$12,566	$ 17,909
1964	1,974	5,843	108,259	13,424	19,267
1965	1,783	5,278	83,188	10,760	16,038
1966	1,931	5,735	81,543	10,601	16,336
1968	2,286	6,684	71,667	9,262	15,946
1969	2,150	6,900	74,272	10,175	17,075
1970	2,198	7,252	89,424	13,056	20,308
1971	1,753	6,172	72,796	11,065	17,237

JACKSON COUNTY

	CRUDE OIL BARRELS (000)	CRUDE OIL DOLLAR VALUE (000)	NATURAL GAS MCF* (000)	NATURAL GAS DOLLAR VALUE (000)	TOTAL OIL & GAS DOLLAR VALUE (000)
1963	11,290	33,531	103,418	12,927	46,459
1964	11,773	34,848	102,328	12,689	47,537
1965	12,471	36,913	105,730	13,676	50,589
1966	14,413	42,808	90,424	11,755	54,563
1968	22,732	66,468	78,387	10,130	76,598
1969	27,512	88,293	86,162	11,804	100,097
1970	28,477	93,974	89,219	13,026	107,000
1971	25,908	91,197	82,453	12,533	103,729

MATAGORDA COUNTY

	CRUDE OIL BARRELS (000)	CRUDE OIL DOLLAR VALUE (000)	NATURAL GAS MCF* (000)	NATURAL GAS DOLLAR VALUE (000)	TOTAL OIL & GAS DOLLAR VALUE (000)
1963	6,999	20,787	208,402	26,050	46,837
1964	7,211	21,345	217,464	26,966	48,310
1965	7,013	20,759	175,981	22,762	43,521
1966	7,774	23,088	169,107	21,984	45,072
1968	9,344	27,320	251,821	32,544	59,865
1969	7,847	25,184	233,196	31,948	57,131
1970	7,455	24,603	222,636	32,505	57,108
1971	6,760	23,796	191,448	29,100	52,896

TABLE 2 (Cont.)

OIL AND GAS PRODUCTION BY COUNTY

	VICTORIA COUNTY				
	CRUDE OIL		NATURAL GAS		TOTAL OIL & GAS
	BARRELS (000)	DOLLAR VALUE (000)	MCF* (000)	DOLLAR VALUE (000)	DOLLAR VALUE (000)
1963	5,156	$15,313	78,044	$ 9,756	$25,069
1964	4,513	13,358	82,023	10,171	23,529
1965	4,619	13,671	73,458	9,501	23,172
1966	4,360	12,948	72,307	29,400	22,348
1968	4,380	12,808	58,728	7,590	20,398
1969	4,317	13,854	53,151	7,282	21,136
1970	4,278	14,119	55,839	8,152	22,271
1971	3,843	13,526	46,269	7,033	20,559

* Million Cubic Feet

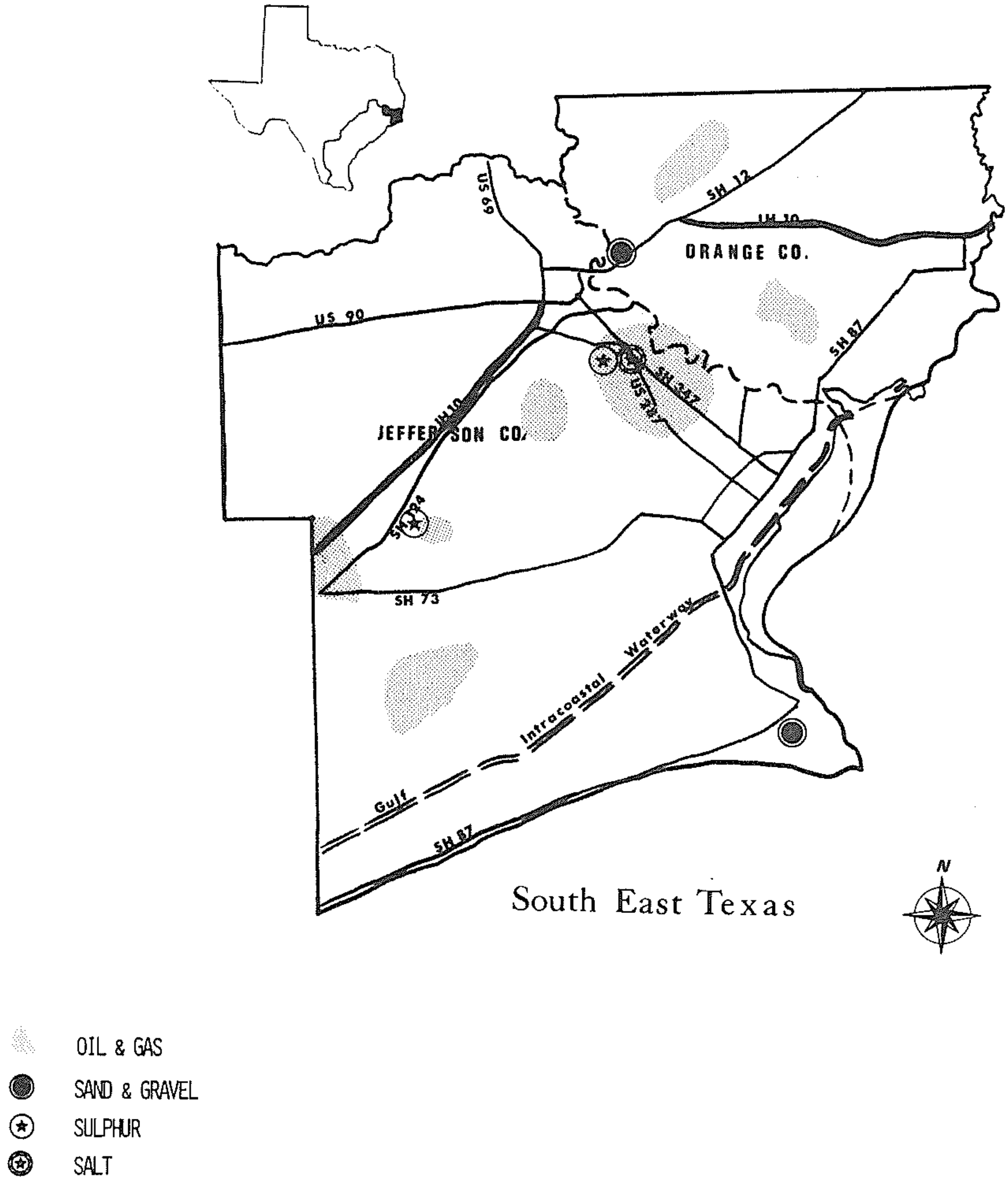
SOURCE: Texas Mid-Continent Oil & Gas Association, Dallas, Texas.

TABLE 3

COUNTY RANK IN TOTAL OIL AND GAS VALUE IN THE STATE

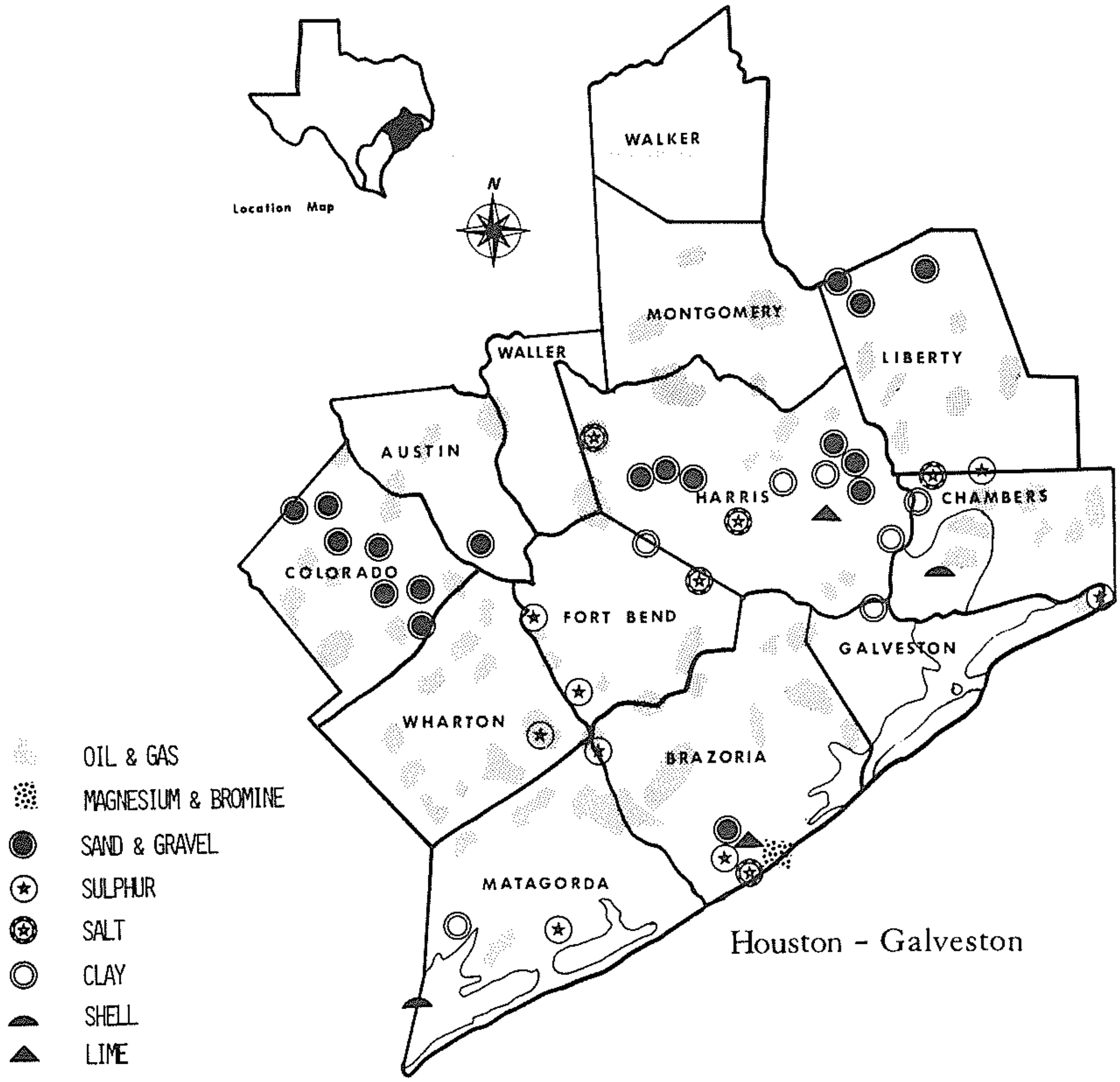
	CALHOUN	JACKSON	MATAGORDA	VICTORIA
1963	63	22	19	43
1964	59	21	20	50
1965	72	21	25	48
1966	69	20	26	55
1968	70	14	21	61
1969	72	12	23	64
1970	68	15	24	64
1971	75	17	30	69

SOURCE: Texas Mid-Continent Oil & Gas Association, Dallas, Texas.



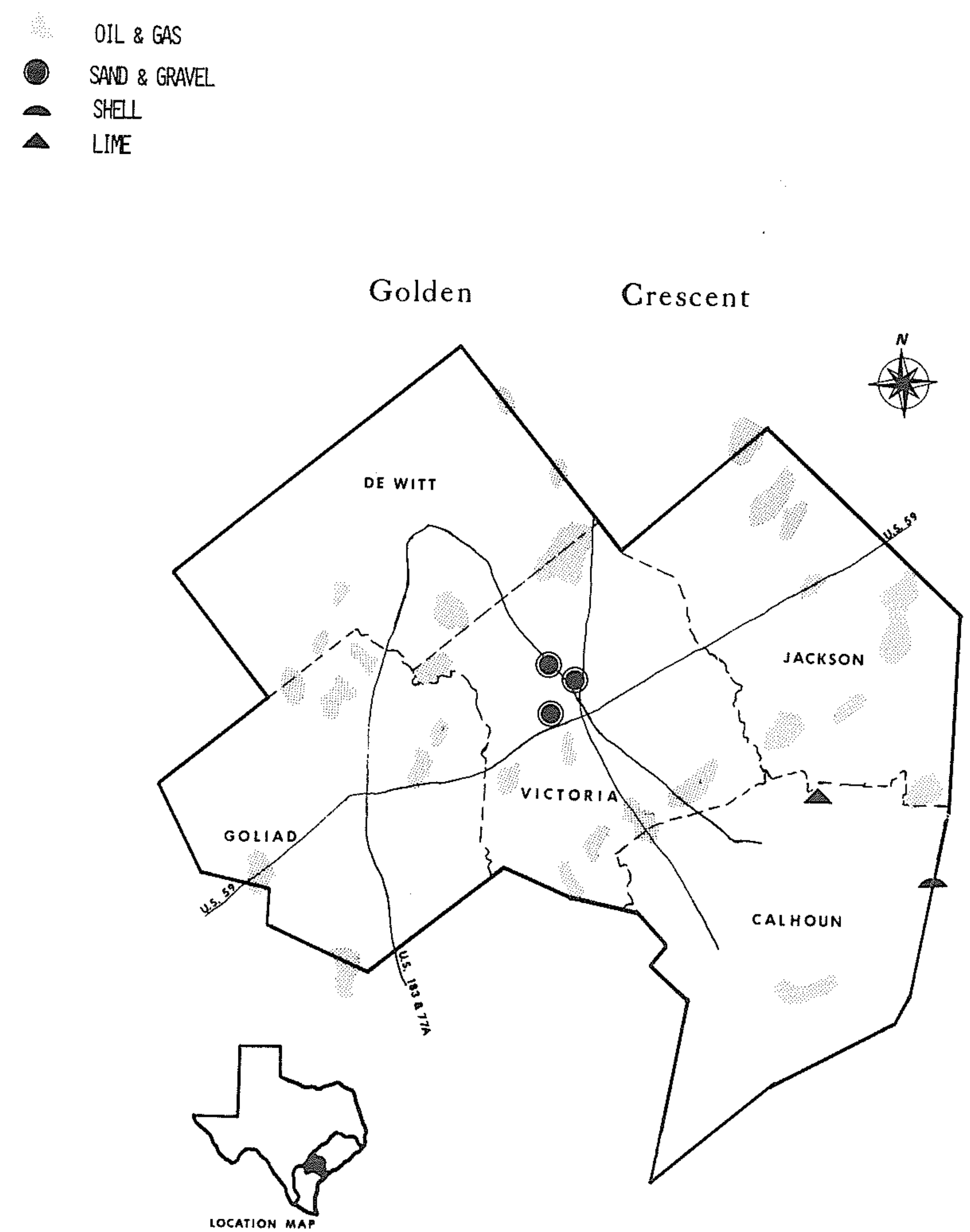
MINERAL LOCATIONS

FIGURE 5



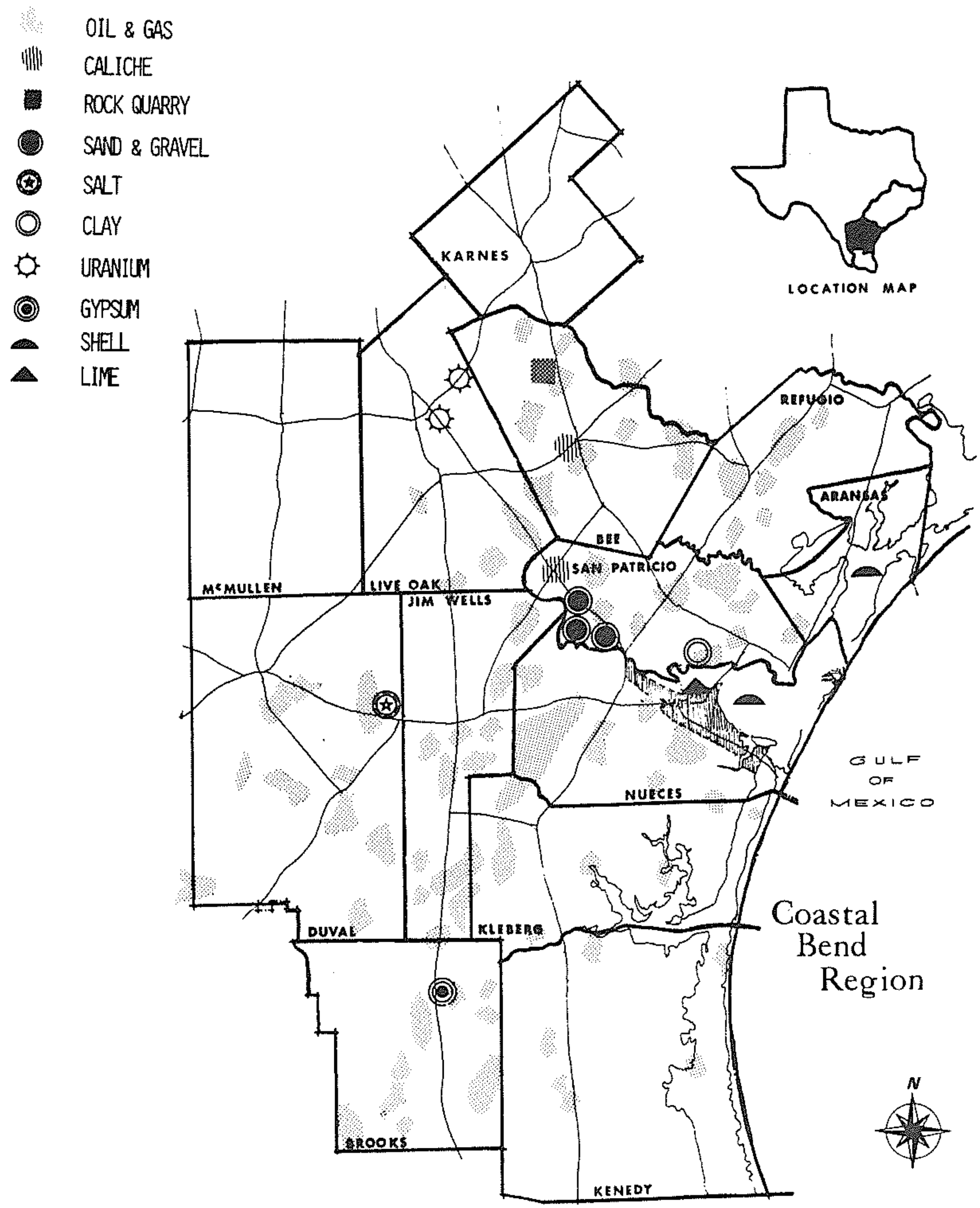
MINERAL LOCATIONS

FIGURE 6



MINERAL LOCATIONS

FIGURE 7



MINERAL LOCATIONS

FIGURE 8

Rock	Salt
Caliche	Clay
Oyster Shell	Sand and Gravel
Uraninite	Sulphur
Magnesium (and Bromine)	

Sulphur

About 87 percent of all sulphur produced is put into sulphuric acid, which is used in many manufacturing processes. Sulphur is produced by two methods: 1) by mining from piercement type salt domes, and 2) by recovery from compounds associated with natural gas and petroleum. All mining of sulphur occurs east of the Colorado River, in one of the major sulphur producing areas in the United States (37 percent of the total 1968 United States sulphur production). Only about 4 percent of the sulphur produced in the Coastal Zone is recovered from oil and gas. The remaining production is accomplished by the Frasch mining process from the porous caprock of 10 salt domes, and about one-half of this from the Boling Dome in Wharton County. Native sulphur impregnates porous limestone and dolomite in the caprock in amounts as high as 50 percent. This caprock is found at depths of 900 to 1200 feet.

There were fifteen sulphur-producing salt plugs, but five have been exhausted. Therefore, the future economic impact of sulphur may be of far less importance to the study area.

Rock

The only true rock quarry in the Coastal Zone is found in Bee County, northwest of Beeville. The rock is a silicified quartzite and is both quarried and crushed at this location.

Caliche

This soft, calcareous rock is quarried in Kleberg, San Patricio, Jim Wells, and Bee Counties.

Oyster Shell

Oyster shell substitutes for industrial limestone which is not found in the coastal region. The shell is dredged from submerged reefs in the bays. The loosened, muddy shell is pulled to the surface, washed, barged to shore, and stockpiled. Shell is used for road materials, in the manufacture of lime, cement, and concrete aggregate, as additive to chicken feeds to aid eggshell formation, and to cattle feed to provide roughage.

Uraninite

Uraninite (unoxidized uranium ore) is mined from open-pit mines north of George West in Live Oak County. Additional deposits of high grade uranium ore are located six miles north of Benavides in Duval County.

Magnesium

Magnesium is extracted from sea water at a plant in Freeport, Brazoria County. This plant produces a large part of the magnesium in the United States.

Rock Salt

Large quantities of salt (sodium chloride) are present as both rock salt and brine. Most salt is used by chemical industries as a raw material. At Hockley Dome in Harris County, rock salt is mined. Brine is obtained from wells in the following locations:

Barbers Hill Dome near Mont Belvieu, Chambers County

Bryan Mont Dome near Freeport, Brazoria County

Pierce Junction Dome near Houston, Harris County

Spindletop Dome near Beaumont, Jefferson County

Blue Ridge Dome near Missouri City, Fort Bend County

A large brine field is also located in Duval County north of Benavides.

Clay

Clay, used in the manufacture of cement, lightweight aggregate, building brick, and structural tile, is produced from open pit strip mines in Harris, Wharton, San Patricio, Galveston, Matagorda, and Fort Bend Counties.

Sand

Sand is used mainly for industrial and constructional purposes. The primary purpose for which sand is mined in the Coastal Zone is for constructional uses. The largest concentration of sand and gravel strip mines in the Coastal Zone is located along the Colorado River between Eagle Lake and Columbus. Significant activity also takes place in Harris County, Victoria County near Victoria, and along the Nueces River in San Patricio and Nueces Counties. Minerals found in each of the four counties are given in Table 4.

TABLE 4

MINERALS FOUND IN THE VICTORIA COUNTY AREA

WITHIN 50 MILES	50 TO 100 MILES	100 TO 200 MILES
Shells	Caliche	Asphaltic Limestone
Sand and Gravel	Grinding Pebbles	Cement Materials
Natural Gas	Lignite	Chromite
Petroleum	Potash	Greensand
Lime	Sulphur	Guano
Clay	Volcanic Ash	Gypsum
Rock	Salt	Kaolin
	Magnesium	Lead
	Bromine	Limestone
	Uranium	Miscellaneous Stone
		Mineral Water
		Molding Sand
		Peat
		Pulverulent Dolomite
		Rice Sand
		Serpentine
		Soapstone
		Tin

TABLE 4 (Cont.)

MINERALS FOUND IN THE CALHOUN AND JACKSON COUNTY AREAS

WITHIN 50 MILES	50 TO 100 MILES	100 TO 200 MILES
Shells	Caliche	Asphaltic Limestone
Sand and Gravel	Grinding Pebbles	Cement Materials
Natural Gas	Lignite	Chromite
Petroleum	Potash	Greensand
Lime	Volcanic Ash	Guano
Clay	Salt	Gypsum
Sulphur	Rock	Kaolin
	Magnesium	Lead
	Bromide	Limestone
	Uranium	Miscellaneous Stone
		Mineral Water
		Molding Sand
		Peat
		Pulverulent Dolomite
		Rice Sand
		Serpentine
		Soapstone
		Tin

MINERALS FOUND IN MATAGORDA COUNTY

WITHIN 50 MILES	50 TO 100 MILES	100 TO 200 MILES
Bromine	Cement Materials	Coal
Clays	Rock	Limestone
Lime	Uranium	Gypsum
Magnesium	Caliche	Chromite
Natural Gas	Grinding Pebbles	Greensand
Petroleum	Lignite	Guano
Salt	Potash	Kaolin
Sand and Gravel	Volcanic Ash	Lead
Shell		Miscellaneous Stone
Sulphur		Mineral Water
		Molding Sand
		Peat
		Pulverulent Dolomite
		Rice Sand
		Serpentine
		Soapstone
		Tin

SOURCE: Mineral Location Map of Texas, Bureau of Economic Geology, Publication 4301, The University of Texas, Austin, Texas.

Water Resources

Ground water is found in Gulf Coast strata which may form belts parallel to the coastline. The belts are not uniform in composition or thickness. The Texas Water Development Board reports that ground water moves toward the coast in typical coastal aquifers at a rate of 10 to 20 feet per year, depending upon the type of sediment through which the ground water passes.[1]

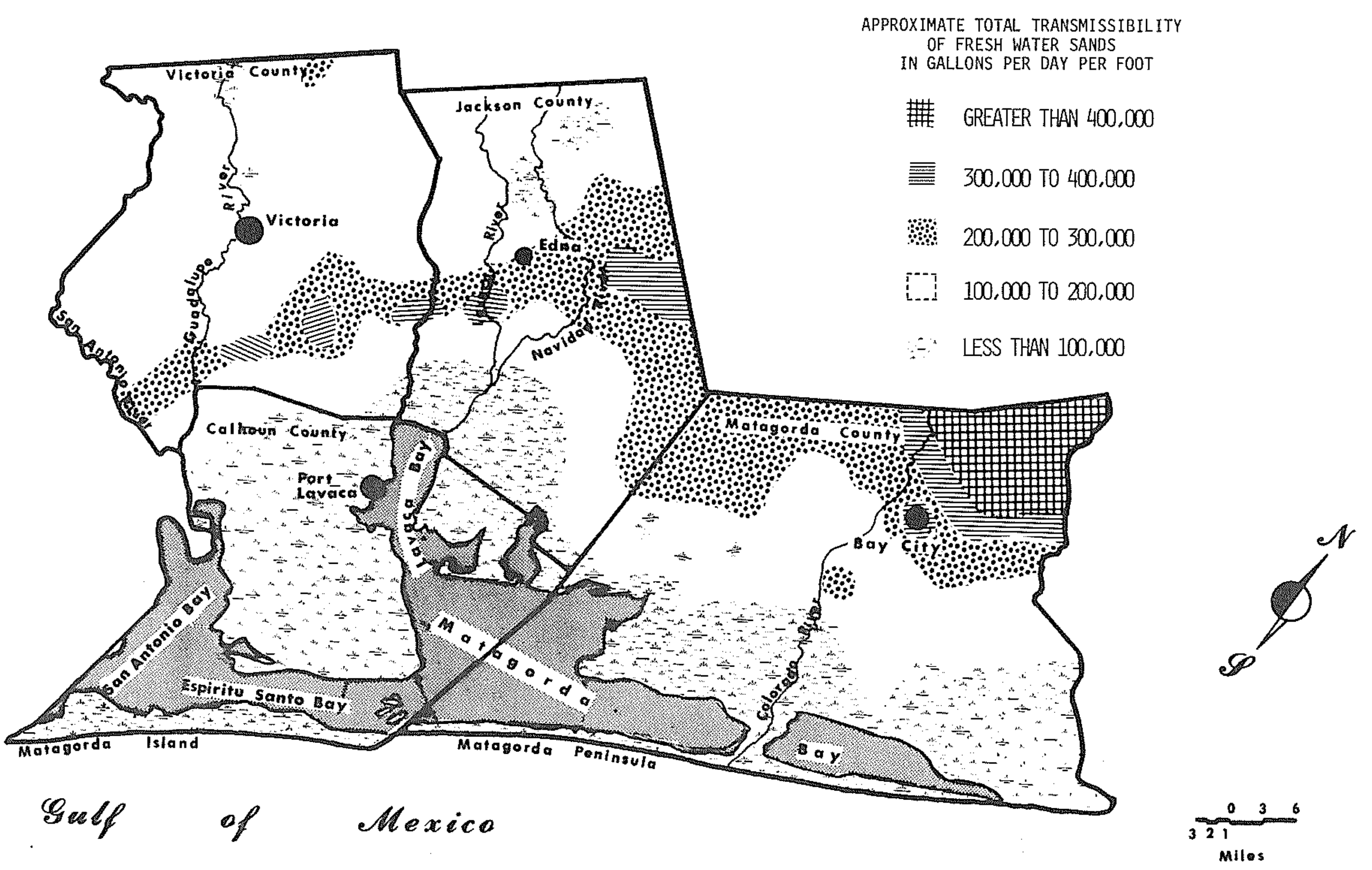
The utilization of ground water in the study area is dependent on the following points:

1. The capacity of the aquifer to yield water
2. The estimated amount of ground water in storage
3. The estimated recharge rate
4. The current rate of pumpage
5. The subsidence of the land and salt water encroachment
6. The quality of ground water

These factors are discussed in more detail in an unpublished report from the Texas Water Development Board, by J.D. Beffort, entitled Ground Water Resources in the Vicinity of the Palmetto Bend Reservoir. Figure 9 shows the areas which are geologically most amenable to water production.

Table 5 indicates the amount of fresh ground water that is estimated to lie in storage in the six counties in consideration. The potential yearly yield of fresh water in storage by county is found in Table 6.

If ground water is used faster than it is replaced by recharge, the restoration rate is unknown; moreover, it may be impossible to replenish the water resource. The main source of recharge for ground water is rainfall, but only a small percentage of rain water becomes a part of the ground water supply. Based upon Texas Water Development Board reports, the following



AREAS MOST FAVORABLE FOR
GROUND WATER DEVELOPMENT

FIGURE 9

TABLE 5

FRESH GROUND WATER IN STORAGE

COUNTY	ACRE FEET OF WATER IN STORAGE
Calhoun	20,000,000
Jackson	95,000,000
Lavaca	46,900,000
Matagorda	31,240,000
Victoria	59,000,000
Wharton	43,142,400
Total	295,282,400

SOURCE: Ground Water Resources in the Vicinity of Palmetto Bend Reservoir, J. D. Beffort, Texas Water Development Board, Unpublished.

TABLE 6

POTENTIAL ANNUAL YIELD OF FRESH WATER IN STORAGE

COUNTY	POTENTIAL ANNUAL YIELD
Calhoun	9,900
Jackson	339,000
Lavaca	272,020
Matagorda	51,920
Victoria	66,375
Wharton	143,059
Total	882,274

SOURCE: Ground Water Resources in the Vicinity of Palmetto Bend Reservoir, J. D. Beffort, Texas Water Development Board, June, 1972, Austin, Texas, Unpublished.

factors are considered in estimating recharge rates:

1.	Average annual rainfall (inches)	37.85
2.	Six county total acres	2,218,880
3.	Six county total annual rainfall in acre feet	7,011,660
4.	Annual net evaporation (inches)	25
5.	Annual acre feet evaporated in the counties	4,615,270
6.	Measured runoff per year (inches)	4.9
7.	Annual runoff in acre feet for the six counties	911,060
8.	Total transpiration by brushland and woods (acre feet)	545,100
9.	Combined evaporation, runoff, and transpiration in acre feet per year	6,071,430
10.	Remainder available for ground water recharge in acre feet per year	940,230

Recharge rates can also be estimated by a method presented in U.S. Geological Survey Water Supply Paper 1468. Using this method, recharge for the six county area totals 355,020 acre feet per year. This is about 38 percent of the 940,230 acre feet estimated above. As is pointed out, the annual recharge rate cannot be ascertained with 100 percent accuracy, therefore, it is difficult to establish definitive guidelines on pumpage rates that do not exploit ground water storage to a dangerous level.

Table 7 indicates pumpage rates by use in Calhoun, Jackson, Matagorda, and Victoria Counties. Table 8 lists total pumpage by river basin. The latter table shows that total ground water pumpage in 1970 for the area is about 5 percent below the minimum estimated recharge rate. Table 9 shows the percentage change by year since 1959 of the pumpage estimates indicated on Table 8. If only the years 1967 through 1970 are considered, it is seen that there has been an average of about a 10 percent increase in

TABLE 7

GROUND WATER PUMPAGE IN ACRE FEET

CALHOUN COUNTY

USES	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Municipal	888	869	903	1,017	1,098	1,153	1,143	1,290	1,411	1,501	1,493	1,563	809
Industrial	3	6	112	112	112	117	117	117	121	120	127	128	128
Domestic & Stock	500	500	500	500	500	500	500	500	500	500	500	500	500
Irrigation	260	240	220	200	500	600	594	700	900	1,100	1,300	1,544	1,600
Total	1,651	1,615	1,735	1,829	2,210	2,370	2,354	2,607	2,932	3,221	3,420	3,735	3,037

JACKSON COUNTY

USES	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Municipal	945	1,437	874	922	920	1,380	1,267	1,252	1,315	1,339	1,261	1,388	1,068
Industrial	819	1,066	1,286	1,257	1,537	1,940	1,752	2,223	2,655	2,573	2,969	3,160	2,910
Domestic & Stock	729	729	729	729	729	729	729	729	729	729	729	729	729
Irrigation	91,858	64,801	44,011	29,334	80,254	88,100	84,221	90,000	95,000	100,000	105,000	114,128	120,000
Total	94,351	68,033	46,900	32,242	83,440	92,149	87,969	94,204	99,699	104,641	109,959	119,405	124,707

TABLE 7 (Cont.)

GROUND WATER PUMPAGE IN ACRE FEET

MATAGORDA COUNTY

USES	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Municipal	744	725	749	742	712	442	673	468	513	509	510	585	652
Industrial	145	1	1	1	0	2	2	1	1	1	1	5	782
Domestic & Stock	410	410	410	410	410	410	410	410	410	410	410	410	410
Irrigation	7,350	4,480	3,860	4,700	6,900	9,850	11,050	9,850	6,500	8,000	9,500	11,000	12,500
Total	8,649	5,616	5,020	5,853	8,022	10,704	12,135	10,729	7,424	8,920	10,421	12,000	14,344

VICTORIA COUNTY

USES	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Municipal	4,491	3,346	3,456	3,705	4,440	4,917	4,790	4,659	5,420	6,635	5,944	6,449	6,626
Industrial	1,318	1,002	1,303	1,614	1,787	919	1,067	1,320	1,436	1,463	1,523	1,383	1,389
Domestic & Stock	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
Irrigation	15,715	12,000	11,500	11,000	12,000	14,000	13,067	14,500	15,000	15,500	16,000	17,338	18,000
Total	23,224	18,048	17,959	18,019	19,927	21,536	20,624	22,179	23,556	25,298	25,167	26,870	27,715

SOURCE: Ground Water Resources in the Vicinity of Palmetto Bend Reservoir, J. D. Beffort, Texas Water Development Board, June, 1972, Austin, Texas.

TABLE 8

GROUND WATER PUMPAGE IN ACRE FEET

COLORADO AND LAVACA AND GUADALUPE BASIN TOTALS

COUNTIES	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Calhoun	1,651	1,615	1,735	1,829	2,210	2,370	2,354	2,607	2,932	3,221	3,420	3,735	3,037
Jackson	94,351	68,033	46,900	32,242	83,440	92,149	87,969	94,204	99,699	104,641	109,959	119,405	124,707
Lavaca	14,569	13,127	12,624	12,073	14,192	17,009	16,759	17,501	18,811	20,328	21,541	24,083	25,210
Matagorda	8,649	5,616	5,020	5,853	8,022	10,704	12,135	10,729	7,424	8,920	10,421	12,000	14,344
Victoria	23,224	18,048	17,959	18,019	19,927	21,536	20,624	22,179	23,556	25,298	25,167	26,870	27,715
Wharton	78,990	47,840	41,760	50,278	61,324	71,551	77,177	71,452	62,396	82,370	102,451	135,424	142,238
Total	221,434	154,279	125,998	120,294	189,115	215,319	217,018	218,672	214,818	244,778	272,959	321,517	337,251

SOURCE: _Ground Water Resources in the Vicinity of Palmetto Bend Reservoir_, J. D. Beffort, Texas Water Development Board, June, 1972, Austin, Texas.

TABLE 10

PERCENTAGE CHANGE OF GROUND WATER PUMPAGE BY YEAR

1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
	- 30.33	-18.33	4.53	+57.21	+13.86	+ 0.79	+ 0.77	-1.76	+13.95	+11.51	+17.79	+4.89

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

pumpage per year. This increase may not continue, but if it does, the following pumpage rates in acre feet are realistic projected values:

1971 - 370,976	1977 - 657,458
1972 - 408,073	1978 - 722,923
1973 - 448,880	1979 - 795,215
1974 - 493,768	1980 - 874,736
1975 - 543,144	1981 - 962,209
1976 - 597,458	1982 - 1,058,429

If the need for ground water would continue to increase at the average rate shown (10 percent per year), the maximum recharge rate would be surpassed in the year 1981. On the other hand, if we view the percentages from 1958 through 1970 and analyze them as a unit, a 52 percent increase is seen over twelve years. If this slower rate of change is projected, the following needs in acre feet of ground water are depicted: 1982 - 512,522; 1994 - 779,033; and 2006 - 1,184,130. Thus, this trend surpasses the maximum estimated recharge rate close to the year 2000.

Based upon more liberal recharge estimates, it is projected that by the year 2000, pumpage will exceed recharge. Thus, unless present trends are significantly modified, the ground water supply may become critically depleted in the study area.

Ground water depletion has two side effects that must be considered: land subsidence and salt water encroachment. Clay beds in the aquifer contain significant amounts of water and when heavy pumping of sand beds occurs, the clays compact as they release water to the sand beds, thus causing land subsidence. In the study area, a land subsidence that ranged from 0.128 feet to 1.014 feet was detected. The Texas Water Development Board Report 91[2] reported that about one foot of land subsidence occurs for about every 100 feet of water level decline.

Salt water encroachment occurs when heavy pumping reverses the natural pressure gradient between fresh and salt water in the aquifer, thus allowing salt water to move into sands that formerly contained fresh water. Both salt water encroachment and land subsidence are hazards when Gulf coastal aquifer is heavily pumped. In parts of Calhoun, Jackson, and Victoria Counties fresh water may be overlain or interlayered with saline water. As the fresh water is pumped out of a bed, the sediments containing saline water may gradually allow downward periolation of salt water into water wells. Thus, saline water may become mixed with the fresh water that is pumped to the surface.

Only Calhoun County, of the counties in the study area, has difficulty obtaining an ample supply of fresh water. In that case slightly saline water is used for livestock, and in some cases for domestic consumption. The southern and southeastern portions of Jackson County have a limited supply of fresh water. Most of the fresh water supply in the study area is "hard" to "very hard," owing to the large amount of dissolved minerals.

TRANSPORTATION

Within the 36 county Texas coastal zone alone, there is located approximately 50 percent of the nation's petrochemical industry and 25 percent of the nation's refining capacity.[3] Table 10 indicates that 1) shipments of goods into and out of Texas is almost three-fourths waterborne, and 2) that this waterborne commerce is heavily influenced by the petroleum industry.

Table 11 shows that within the coastal zone region of the State, the predominance of waterborne trade is greater still, accounting for almost 90 percent of all commodities shipped.

TABLE 10

DISTRIBUTION OF TEXAS TONNAGE SHIPMENTS BY MODE

MODE	PERCENT OF TONS SHIPPED: ALL COMMODITIES	PERCENT OF TONS SHIPPED: COMMODITIES OTHER THAN PETROLEUM AND COAL
Rail	11.7	39.9
Common Motor Carrier	8.4	23.9
Private Truck	6.0	19.9
Air	___	___
Water	73.8	15.9
Other	0.1	0.4
Total	100.0	100.0

* Does not include pipeline shipments.

SOURCE: Transportation in the Texas Coastal Zone, Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

15 Transportation in the Texas Coastal Zone, prepared by the Texas Transportation Institute, Texas A&M University, 1973, pp. II-5, College Station, Texas.

42

TABLE 11

MODAL DISTRIBUTION OF GOODS SHIPPED FROM THE TEXAS COASTAL ZONE

MODE	PERCENT OF TONS SHIPPED: ALL COMMODITIES
Rail	6.4
Truck	4.4
Air	___
Water	89.2
Total	100.0

* Does not include pipeline shipments.

SOURCE: Transportation in the Texas Coastal Zone, prepared by the Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

A brief analysis of Table 12 indicates that petroleum refining, petroleum production, banking and insurance, and agriculture are the four major economic sectors in the State, and that three of these four depend entirely upon the transportation industry for their value. Of these, the first two, representing 78 percent of the output shown, would be severely hampered without waterborne shipping.

Table 13 places Texas in national perspective with respect to total volume of waterborne commerce. (Texas ranks second only to the State of New York in total tonnage handled by ports).

The "Internal" figures listed in these tables include the Gulf Intracoastal Waterway and the river systems. "Local" means the movement of freight within the confines of a port, and "Intraterritorial" indicates traffic from U.S. ports to Puerto Rico and the Virgin Islands. "Coastwise" is limited to ocean-going domestic traffic, "Foreign" is self-explanatory, and "Lakewise" refers to traffic originating and terminating within the Great Lakes.

The existing modes of the transportation system that serve the State and the study area include highway, rail, air, pipeline, inland waterway, and ocean traffic. Each of these major elements must offer a viable means of transportation to the economy of the region if the area is to thrive.

Port Facilities of the Texas Coastal Zone

At present, there are fourteen deep water ports along the Texas Gulf coast. They are located at the following points:

1. Beaumont
2. Brownsville
3. Corpus Christi
4. Freeport
5. Galveston
6. Houston
7. Orange
8. Port Aransas
9. Port Arthur
10. Port Isabel
11. Port Mansfield
12. Sabine Pass
13. Texas City
14. Port of Port Lavaca-Point Comfort

TABLE 12

MAJOR ECONOMIC SECTORS IN TEXAS

SECTOR	ANNUAL OUTPUT BILLIONS OF DOLLARS
1. Petroleum Refining	6.6
2. Petroleum Production	4.4
3. Banking and Insurance	1.8
4. Agriculture	1.3

SOURCE: Transportation in the Texas Coastal Zone, prepared by the Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

TABLE 13

WATERBORNE COMMERCE OF THE UNITED STATES AND TEXAS
1965 AND 1970

CATEGORY	TONS (000'S) UNITED STATES 1965	1970	TEXAS 1965	1970	PERCENT OF UNITED STATES 1965	1970
Total	1,272,896	1,531,697	190,174	193,174	15.0	12.6
Foreign Imports	269,835	334,340	12,167	14,544	4.5	4.3
Foreign Exports	173,892	241,629	23,341	25,246	13.4	10.4
Coastwise	201,508	238,440	82,399	78,253	40.9	32.8
Lakewise	153,695	157,059	---	---	--	--
Internal	369,615	472,123	63,067	70,975	17.1	15.0
Local	102,865	81,475	9,551	4,150	9.3	5.1
Intraterritorial	1,486	1,630	----	----	--	--

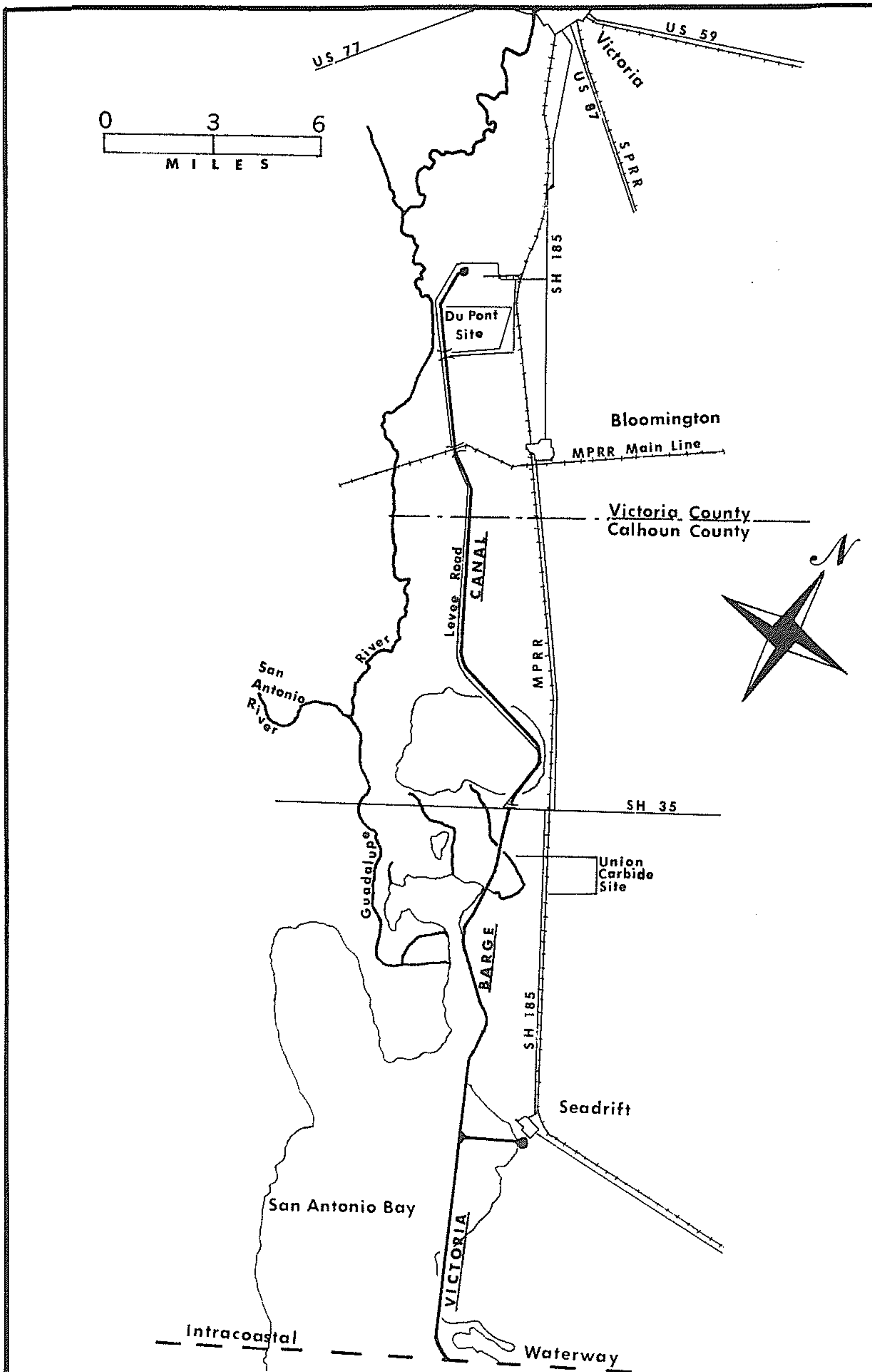
SOURCE: Texas Waterborne Commerce Commodity Flow Statistics, The Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

Excluding Port Mansfield, Sabine Pass and Port Aransas, information on port facilities is provided on each port in a report entitled An Economic Feasibility Study for the Future Expansion of the Port of Port Lavaca-Point Comfort, prepared by the Industrial Economics Research Division, Texas A&M University, 1969, College Station, Texas, and Texas Waterborne Commerce Commodity Flow Statistics, prepared by the Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

Barge Canals

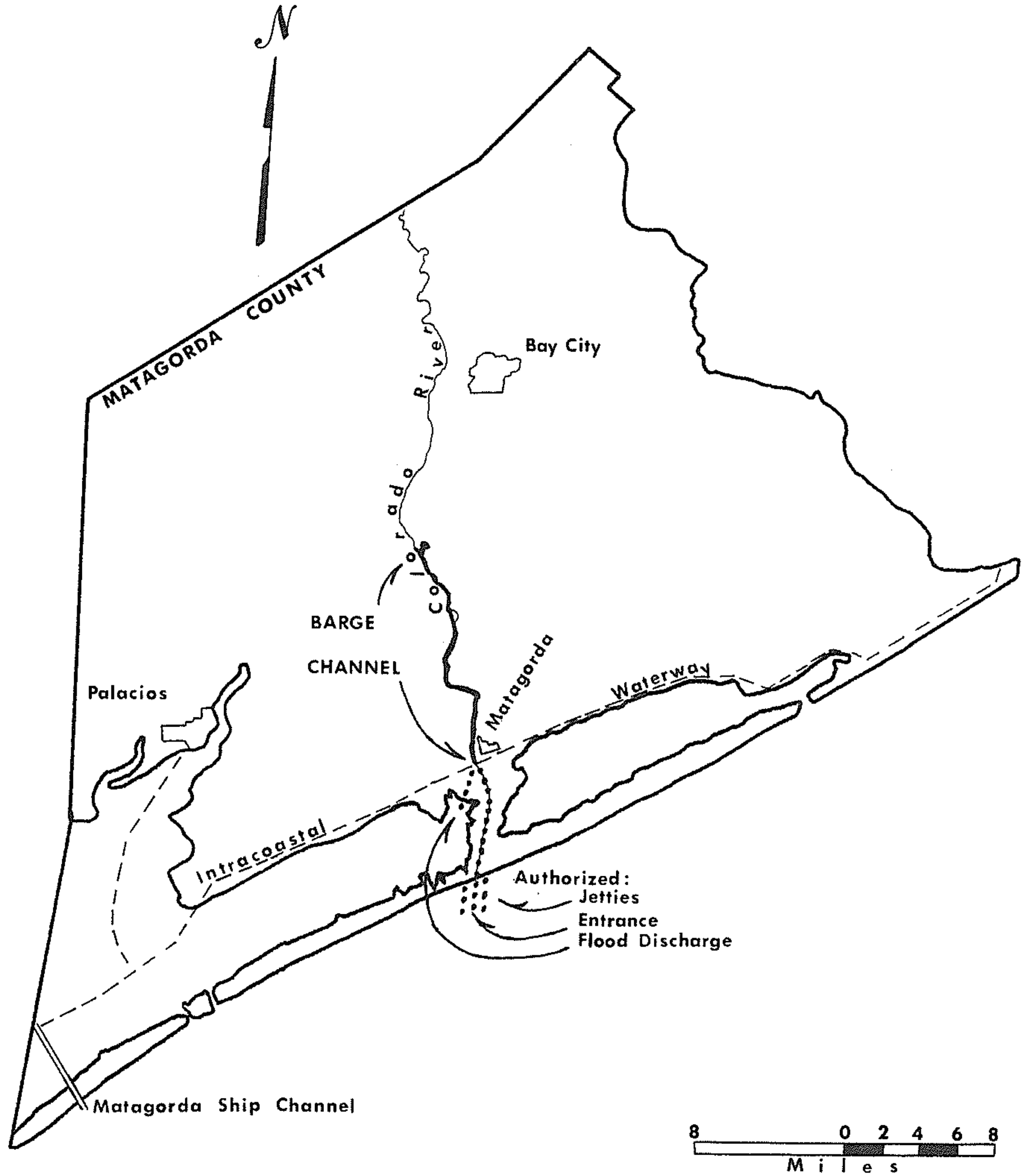
The Victoria Barge Canal in Victoria and Calhoun Counties, extends from near Seadrift, Texas, 34.6 miles northwest to the Victoria, Texas Turning Basin. The route of the sea level canal is adjacent to and crosses eastern San Antonio Bay and skirts the eastern edges of Mission Lake, Green Lake and the Guadalupe River. The canal is over 9 feet deep and 100 feet wide with a minimum vertical clearance of 51 feet, and a minimum horizontal clearance of 75 feet. The canal is owned and operated by the Victoria County Navigation District and the West Side Calhoun County Navigation District, each operating the portions in their respective counties. The major shippers located along the canal are the DuPont and Union Carbide plants and two sand and gravel companies. Union Carbide operates its own fleet of barges, and DuPont is principally served by the American Commercial Barge Lines. All major barge companies operating on the Texas Intracoastal Waterway system can operate barges on this canal.[4] See Figure 10 for a graphic description.

The Colorado River Barge Canal, as seen in Figure 11, is 9 feet deep, 100 feet wide and extends a total of 15.5 miles upstream from the intracoastal waterway to an off-channel turning basin below Bay City. The turning basin is 400 X 500 feet.



VICTORIA BARGE CANAL

FIGURE 10



COLORADO RIVER CHANNEL

FIGURE 11

The last tributary of the intracoastal canal in the study area serves the city of Palacios. This channel is 12 feet deep and 125 feet wide.[5]

Waterborne Transportation

The categories of waterborne shipping for the two main area ports are outlined on Table 14. "Ocean Traffic" includes all ocean-going trade both foreign and domestic, while "Internal Traffic" is as previously defined: the Gulf Intracoastal Waterway traffic and that on the river systems. Although the Matagorda and Victoria channels appear to have equal distribution between ocean-going and internal traffice (52.34 percent/47.66 percent), it is apparent that 47.65 percent of all traffic lies within the specific area of foreign imports, whereas this same category accounts for only 7.53 percent of Texas traffic. Foreign exports from the study area amount to only 3.75 percent of total traffic for the two channels, as compared to a 13.07 percent for the State. Possibly the most serious imbalance is indicated by the "Coastwise" data which show only 0.94 percent of the total traffic for the study area versus a 40.51 percent for the State.

Table 15 reviews the Matagorda and Victoria channel tonnage in relation to State totals. The only sector in which area facilities are handling a significant share of the State totals in 1970 is in "Foreign Imports" and a comparison of 1965 and 1970 data show that since 1965 there has been an increase in this category, while "Internal" traffic for these area ports decreased in the same period. Although area data except for "Foreign Imports" is low, there has been a 10.96 percent increase in the local share of State commerce from 1965 to 1970. This increase has been in all areas except "Internal" and "Local" traffic.

TABLE 14

WATERBORNE COMMERCE - MODAL COMPARISON
FOR TEXAS AND MAJOR AREA PORTS - 1970

CATEGORY	PERCENT TEXAS PORTS	 MATAGORDA/ VICTORIA CHANNELS
Ocean Traffic	61.11	52.34
Foreign	20.60	51.40
Import	7.53	47.65
Export	13.07	3.75
Coastwise	40.51	0.94
Receipts	3.70	0.94
Shipments	36.81	0.00
Internal Traffic	36.74	47.66
Receipts	21.53	18.49
Shipments	15.21	29.17

SOURCE: Texas Waterborne Commerce Commodity Flow Statistics, Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

TABLE 15

TEXAS AND MAJOR AREA CHANNEL TONNAGE
1965-1970

CATEGORY	TEXAS 1965	MATAGORDA AND VICTORIA CHANNELS 1965	PERCENT OF TEXAS
Foreign Imports	12,167,248	772,158	6.35
Foreign Exports	23,340,798	3,991	0.02
Coastwise	82,399,398	14,544	0.02
Internal	63,067,163	4,496,875	7.13
Local	9,550,774	270,705	2.83
Total	190,173,770	5,558,273	2.92

CATEGORY	TEXAS 1970	MATAGORDA AND VICTORIA CHANNELS 1970	PERCENT OF TEXAS
Foreign Imports	14,544,442	2,981,243	20.50
Foreign Exports	25,245,934	234,937	0.93
Coastwise	78,252,562	58,960	0.08
Internal	70,974,661	2,982,057	4.20
Local	4,150,158	-0-	0.00
Total	193,173,770	6,257,197	3.24

SOURCE: Texas Waterborne Commerce Commodity Flow Statistics, Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

Table 16 outlines the 1965-1970 traffic for the Matagorda ship channel. A shift occurred in total volume from 76.91 percent "Internal" to 66.56 percent "Foreign Import." In the category of "Internal-Receipts" a 77 percent loss occurred, while "Internal-Shipments" showed a 47 percent loss. The major increase in ocean-going traffic, "Foreign Imports," amounted to 2,209,085 tons or a 286 percent rise.

A view of these trends for the year 1971 is shown in Table 17. "Foreign-Imports" continued to increase while exports decreased slightly. "Coastwise-Receipts" have climbed steadily since 1965, as reflected in a tonnage increase from 14,544 tons to 80,733. "Coastwise-Shipments" have remained negligible, although still decreasing in percentage of total traffic, "Internal-Shipments" ended a decline and began to rise. "Internal-Receipts" continued to decrease, but more slowly. Between 1965 and 1970, there was a total drop in tonnage of 117,910 tons (0.03 percent), and in 1971 a 4.7 percent increase over 1970 (210,510 tons) took place.

Table 18 shows freight traffic tonnage for 1965, 1970 and 1971 traveling the Matagorda ship channel by SIC number. From this information, it can readily be ascertained that SIC 1051 (Aluminum ores, Concentrates) figured in the majority of trade in 1965 (55 percent). In 1971 this trade increased to 68 percent of all traffic shipped on the Matagorda channel. There were minor increases from 1965 to 1971 in ship traffic handling chemical products, primarily within SIC's 2818 (Sulfuric Acid), 2819 (Basic Chemicals and Products, nec), and 2891 (Miscellaneous Chemical Products). Shipments of crude petroleum remained fairly constant, increasing 8.5 percent. It is interesting to note that total traffic in marine shells decreased by 77 percent, with all shipments outgoing ceasing by 1971.

TABLE 16

MATAGORDA SHIP CHANNEL TONNAGE 1965-1970

CATEGORY		PERCENT OF TOTAL TRAFFIC 1965	PERCENT OF TOTAL TRAFFIC 1970	ABSOLUTE INCREASE/DECREASE 1965-1970		
% Foreign Imports	=	16.80	66.56	+ 286 % or	2,209,085 Tons	Increase
% Foreign Exports	=	0.09	5.24	+ 579 % or	230,946 Tons	Increase
% Coastwise Receipts	=	0.31	1.32	+ 305 % or	44,416 Tons	Increase
% Coastwise Shipments	=	0.00	0.00	- - - - - - - - - - -		
% Internal Receipts	=	48.91	11.77	- 77 % or	1,721,116 Tons	Decrease
% Internal Shipments	=	28.00	15.11	- 47 % or	610,536 Tons	Decrease
% Local	=	5.89	0.00	- 100 % or	270,705 Tons	Decrease
Total	=	100.00	100.00	- 0.03% or	117,910 Tons	Decrease

SOURCE: Texas Waterborne Commerce Commodity Flow Statistics, Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 17

MATAGORDA SHIP CHANNEL TONNAGE 1970-1971

CATEGORY		PERCENT OF TOTAL TRAFFIC 1970	1971	ABSOLUTE INCREASE/DECREASE 1970-1971	
% Foreign Imports	=	66.56	67.89	+ 6.80 % or 202,693 Tons	Increase
% Foreign Exports	=	5.24	4.85	- 3.20 % or 7,519 Tons	Decrease
% Coastwise Receipts	=	1.32	1.72	+ 36.93 % or 21,773 Tons	Increase
% Coastwise Shipments	=	0.00	0.07	3,064 Tons	Increase
% Internal Receipts	=	11.77	10.54	- 6.26 % or 32,994 Tons	Decrease
% Internal Shipments	=	15.11	14.93	+ 3.47 % or 23,493 Tons	Increase
% Local	=	0.00	0.00	- - - - - - - - - -	
Total	=	100.00	100.00	+ 4.70 % or 210,510 Tons	Increase

SOURCE: Waterborne Commerce of the United States, Calendar Years 1970 and 1971. Part 2, Waterways and Harbors Gulf Coast, Mississippi River System and Antilles, Department of the Army, Corps of Engineers, Vicksburg, Mississippi, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 18

MATAGORDA SHIP CHANNEL, FREIGHT TRAFFIC TONNAGE 1965, 1970, and 1971

1965

COMMODITY	TOTAL	FOREIGN IMPORTS	FOREIGN EXPORTS	DOMESTIC COASTWISE RECEIPTS	DOMESTIC INTERNAL RECEIPTS	DOMESTIC INTERNAL SHIPMENTS	LOCAL
Total	4,597,167	772,158	3,991	14,544	2,248,536	1,287,233	270,705
0122 Hay and fodder	185	-------	185	------	---------	---------	-------
0151 Live animals	485	-------	485	------	---------	---------	-------
0931 Marine shells, unmanufactured	445,479	-------	-----	------	128,516	53,958	263,005
1051 Aluminum ores, concentrates	2,534,461	765,086	-----	------	1,769,375	---------	-------
1311 Crude petroleum	559,693	-------	-----	------	5,498	554,195	-------
1451 Clay	200	-------	-----	------	---------	200	-------
1471 Phosphate rock	10,854	-------	-----	------	---------	10,854	-------
1499 Nonmetallic minerals, nec	7,061	7,061	-----	------	---------	---------	-------
2810 Sodium hydroxide	154,665	-------	-----	------	152,817	1,848	-------
2811 Crude tar, oil, gas products	25,342	-------	-----	------	---------	25,342	-------
2813 Alcohols	8	-------	8	------	---------	---------	-------
2814 Sulphuric acid	106,767	-------	45	------	106,722	---------	-------
2819 Basic chemicals and prod, nec	5,632	-------	3,097	------	---------	2,535	-------
2822 Synthetic rubber	168	-------	168	------	---------	---------	-------
2891 Miscellaneous chemical prod	4,878	-------	-----	------	---------	4,878	-------
2914 Distillate fuel oil	211	-------	-----	------	211	---------	-------
2915 Residual fuel oil	13,112	-------	-----	------	5,676	7,436	-------
2918 Asphalt, tar, and pitches	91,791	-------	-----	14,544	77,247	---------	-------
3317 Iron and steel pipe and tube	584	-------	-----	------	584	---------	-------
3319 Iron and steel products, nec	1,888	-------	-----	------	1,888	---------	-------
3324 Aluminum and alloys, unworked	10,798	-------	-----	------	---------	10,798	-------
3411 Metal containers	20	-------	-----	------	---------	20	-------
3511 Machinery, except electrical	5	-------	3	------	2	---------	-------
3911 Misc. manufactured products	301	11	-----	------	---------	290	-------
4118 Waterway Improvement mat	622,579	-------	-----	------	---------	614,879	7,700

Total ton-miles, 75,976,948.

TABLE 18 (Cont.)

MATAGORDA SHIP CHANNEL, FREIGHT TRAFFIC TONNAGE 1965, 1970, and 1971

	1970					
		FOREIGN		DOMESTIC		
				COASTWISE	INTERNAL	
COMMODITY	TOTAL	IMPORTS	EXPORTS	RECEIPTS	RECEIPTS	SHIPMENTS
Total - - - - - - - - - - - - - - - - -	4,479,257	2,981,243	234,937	58,960	527,420	676,697
0931 Marine shells, unmanufactured - - -	315,727	---------	-------	------	315,727	-------
1051 Aluminum ores, concentrates - - - -	2,948,111	2,948,111	-------	------	-------	-------
1121 Coal and lignite- - - - - - - - - -	45,485	---------	45,485	------	-------	-------
1311 Crude petroleum - - - - - - - - - - -	488,854	---------	-------	------	-------	488,854
1499 Nonmetallic minerals, nec - - - - - -	38,968	33,132	-------	------	5,836	-------
2810 Sodium hydroxide- - - - - - - - - -	556	---------	-------	------	-------	556
2811 Crude tar, oil, gas products- - - -	83,388	---------	-------	7,168	56,065	20,155
2818 Sulphuric acid- - - - - - - - - - - -	115,468	---------	-------	------	115,468	-------
2819 Basic chemicals and prod, nec - - -	190,665	---------	188,925	------	1,393	347
2871 Nitrogenous chem fertilizers- - - -	5,830	---------	-------	------	5,830	-------
2873 Phosphatic chem fertilizers - - - -	1,473	---------	-------	------	1,473	-------
2879 Fertilizer and materials, nec - - -	1,290	---------	-------	------	1,290	-------
2891 Miscellaneous chemical prod - - - -	66,156	---------	-------	------	-------	66,156
2911 Gasoline- - - - - - - - - - - - - - -	16,278	---------	-------	------	-------	16,278
2914 Distillate fuel oil - - - - - - - - -	54	---------	-------	------	54	-------
2915 Residual fuel oil - - - - - - - - - -	24,184	---------	-------	------	24,184	-------
2918 Asphalt, tar and pitches- - - - - -	51,792	---------	-------	51,792	-------	-------
2921 Liquefied gases - - - - - - - - - - -	58,280	---------	-------	------	-------	58,280
3313 Coke, pet asphalts, solvents- - - -	3	---------	3	------	-------	-------
3321 Nonferrous metals, nec- - - - - - - -	25	---------	25	------	-------	-------
3324 Aluminum and alloys, unworked - - -	24,605	---------	497	------	-------	24,108
3411 Fabricated metal products - - - - - -	100	---------	-------	------	100	-------
3791 Misc transportation equipment - - -	2	---------	2	------	-------	-------
4029 Waste and scrap, nec- - - - - - - - -	1,963	---------	-------	------	-------	1,963
Total ton-miles, 113,960,571.						

TABLE 18 (Cont.)

MATAGORDA SHIP CHANNEL, FREIGHT TRAFFIC TONNAGE 1965, 1970, and 1971

COMMODITY	1971						
	TOTAL	FOREIGN		DOMESTIC			
				COASTWISE		INTERNAL	
		IMPORTS	EXPORTS	RECEIPTS	SHIPMENTS	RECEIPTS	SHIPMENTS
Total	4,689,767	3,183,936	227,418	80,733	3,064	494,426	700,190
0931 Marine shells, unmanufactured	252,207	---------	-------	------	-----	252,207	-------
1051 Aluminum ores, concentrates	3,149,298	3,149,298	-------	------	-----	-------	-------
1121 Coal and lignite	55,727	---------	55,727	------	-----	-------	-------
1311 Crude petroleum	515,606	---------	-------	------	3,064	-------	512,542
1499 Nonmetallic minerals, nec	34,638	34,638	-------	------	-----	-------	-------
2810 Sodium hydroxide	5,562	---------	-------	------	-----	-------	5,562
2811 Crude tar, oil, gas products	159,861	---------	-------	80,675	-----	53,266	25,920
2817 Benzene and toluene	2,241	---------	-------	------	-----	-------	2,241
2818 Sulphuric acid	139,638	---------	-------	------	-----	139,638	-------
2819 Basic chemicals and prod, nec	187,905	---------	171,317	------	-----	-------	16,588
2871 Nitrogenous chem fertilizers	11,024	---------	-------	------	-----	9,796	1,228
2879 Fertilizer and materials, nec	4,381	---------	-------	------	-----	4,381	-------
2891 Miscellaneous chemical prod	63,612	---------	-------	------	-----	-------	63,612
2911 Gasoline	20,882	---------	-------	------	-----	5,471	15,411
2914 Distillate fuel oil	2,434	---------	-------	------	-----	2,434	-------
2915 Residual fuel oil	28,364	---------	-------	------	-----	27,233	1,131
3317 Iron and steel pipe and tube	324	---------	324	------	-----	-------	-------
3321 Nonferrous metals, nec	1	---------	1	------	-----	-------	-------
3324 Aluminum and alloys, unworked	50,324	---------	-------	------	-----	-------	50,324
3511 Machinery, except electrical	2,456	---------	49	------	-----	-------	2,407
3731 Ships and boats	58	---------	-------	58	-----	-------	-------
4029 Waste and scrap, nec	3,224	---------	-------	------	-----	-------	3,224
Total ton-miles, 117,754,232.							

SOURCE: Waterborne Commerce of the United States, Calendar Years 1965, 1970 and 1971. Part 2, Waterways and Harbors Gulf Coast, Mississippi River System and Antilles. Department of the Army, Corps of Engineers, Vicksburg, Mississippi.

Handling only domestic barge traffic, the Victoria channel showed a 279 percent increase in total tonnage handled between 1965 and 1971. Table 19 shows this channel's year by year increase from 961,106 tons in 1965 to 2,686,164 in 1971. It should be noted that a 73.40 percent rise took place in 1968 and an increase of almost one million tons, or 51.08 percent, took place in 1971.

Table 20 shows the fluctuation in traffic. The greatest traffic increase occurred in shipments - from 508,985 to 2,043,654 tons. This table also shows that the major economic sector lies within SIC 1442 (Sand, Gravel and Crushed Rock). This sector was not listed in 1965, but doubled its output from 708,774 tons in 1970 to 1,491,214 tons in 1971. The other major sector that is indicated is SIC 2819 (Basic Chemicals and Products, not elsewhere classified), which rose from 369,899 tons to 702,279 tons in this same time period. Within SIC 2819 there is a depreciation in "Receipts" where during 1965, 22,589 tons were in receipts, 185,483 tons were shown in 1970, and 177,311 tons showed in 1971 receipts. From 1965 to 1971, SIC 2819 shipments show a steady increase, and total receipts and shipments in this SIC show a 1965-1971 climb of 332,380 tons.

Data for the Colorado Channel is limited. Available information indicates that total commerce in 1965 amounted to 155,868 tons of marine shells, unmanufactured (SIC 0931). Table 21 presents data for 1970 and 1971. From this table, it can be seen that shipments of this commodity decreased by 26 percent, while shipments of SIC 2819 increased by approximately 7 1/2 percent.

Pipelines

The concentration of pipelines is greater in the Texas Coastal Zone than in any other area of comparable size in the world. However, this concentration lies mainly in the Beaumont-Port Arthur, Houston and Corpus Christi

TABLE 19

VICTORIA BARGE CHANNEL

YEAR	TONS	PERCENTAGE INCREASE/DECREASE FROM PREVIOUS YEAR
1965	961,106	+ 34.57
1966	927,629	- 3.48
1967	1,037,597	+ 11.85
1968	1,799,172	+ 73.40
1969	1,893,065	+ 5.22
1970	1,777,940	- 6.08
1971	2,686,164	+ 51.08

Total Tonnage Increase 1965 - 1971 = 1,725,058
Percentage Increase 1965 - 1971 = 279

SOURCE: Texas Waterborne Commerce Commodity Flow Statistics, Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 20

VICTORIA BARGE CHANNEL, FREIGHT TRAFFIC 1965, 1970, and 1971
(TONS)

1965

COMMODITY	TOTAL	INTERNAL RECEIPTS	INTERNAL SHIPMENTS
Total- - - - - - - - - - - - - - - - -	961,106	452,121	508,985
0931 Marine shells, unmanufactured- - -	53,732	53,732	-------
1311 Crude petroleum- - - - - - - - - - -	8,144	8,144	-------
2810 Sodium hydroxide - - - - - - - - - -	265,047	265,047	-------
2813 Alcohols - - - - - - - - - - - - - -	128,279	20,889	107,390
2814 Sulphuric acid - - - - - - - - - - -	224	-------	224
2818 Benzene- - - - - - - - - - - - - - -	59,409	59,409	-------
2819 Basic chemicals and prod, nec- - -	369,899	22,589	347,310
2851 Paints - - - - - - - - - - - - - - -	1,253	-------	1,253
2891 Miscellaneous chemical prod- - - -	19,210	18,906	304
2911 Gasoline - - - - - - - - - - - - - -	11,537	-------	11,537
2913 Kerosene - - - - - - - - - - - - - -	829	-------	829
2916 Lubricating oils and greases - - -	1,085	1,085	-------
2917 Naphtha petroleum solvents - - - -	10,638	-------	10,638
2918 Asphalt, tar, and pitches- - - - -	3,056	1,420	1,636
2991 Petroleum and coal prod, nec - - -	25,296	-------	25,296
3317 Iron and steel pipe and tube - - -	900	900	-------
3411 Metal containers - - - - - - - - - -	159	-------	159
3511 Machinery, except electrical - - -	2,409	-------	2,409
Total ton-miles, 18,948,575.			

1970

COMMODITY	TOTAL	INTERNAL RECEIPTS	INTERNAL SHIPMENTS
Total- - - - - - - - - - - - - - - - -	1,777,940	629,156	1,148,784
0931 Marine shells, unmanufactured- - -	83,470	81,507	1,963
1442 Sand, gravel, crushed rock - - - -	708,774	-------	708,774
2810 Sodium hydroxide - - - - - - - - - -	218,290	216,502	1,788
2813 Alcohols - - - - - - - - - - - - - -	52,890	24,018	28,872
2817 Benzene and toluene- - - - - - - -	109,821	107,130	2,691
2819 Basic chemicals and prod, nec- - -	586,993	185,483	401,510
2913 Kerosene - - - - - - - - - - - - - -	3,186	-------	3,186
2921 Liquefied gases- - - - - - - - - - -	12,849	12,849	---------
3317 Iron and steel pipe and tube - - -	1,667	1,667	---------
Total ton-miles, 45,452,245.			

TABLE 20 (Cont.)

VICTORIA BARGE CHANNEL, FREIGHT TRAFFIC 1965, 1970, and 1971
(TONS)

1971

COMMODITY	TOTAL	INTERNAL	
		RECEIPTS	SHIPMENTS
Total- - - - - - - - - - - - - - - - - -	2,686,164	642,510	2,043,654
0912 Shellfish, except prepared - - - -	5	-------	5
0931 Marine shells, unmanufactured- - -	31,016	31,016	---------
1442 Sand, gravel, crushed rock - - - -	1,491,214	-------	1,491,214
2810 Sodium hydroxide - - - - - - - - - -	273,541	273,541	---------
2813 Alcohols - - - - - - - - - - - - - -	47,665	29,701	17,964
2817 Benzene and toluene- - - - - - - -	86,380	86,380	---------
2819 Basic chemicals and prod, nec- - -	702,279	177,311	524,968
2921 Liquefied gases- - - - - - - - - -	53,019	43,516	9,503
3731 Ships and boats- - - - - - - - - -	1,045	1,045	---------
Total ton-miles, 74,618,578.			

SOURCE: Waterborne Commerce of the United States, Calendar Years 1965, 1970, and 1971. Part 2, Waterways and Harbors Gulf Coast, Mississippi River System and Antilles. Department of the Army, Corps of Engineers, Vicksburg, Mississippi.

TABLE 21

COLORADO RIVER, TEXAS

1970

IN-BOUND

COMMODITY	SHORT TONS
0931 Marine Shells, unmanufactured	111,568
2819 Basic Chemicals & Products, NEC	93,071
Total	204,639

OUT-BOUND

COMMODITY	SHORT TONS
2813 Alcohol	29,438
2819 Basic Chemicals & Products, NEC	4,355
Total	33,793
Grand Total - All Traffic	238,432

1971

IN-BOUND

COMMODITY	SHORT TONS
0931 Marine Shells, unmanufactured	82,212
2819 Basic Chemicals & Products, NEC	100,020
Total	182,232

OUT-BOUND

COMMODITY	SHORT TONS
2813 Alcohol	18,682
2819 Basic Chemicals & Products, NEC	8,298
2821 Plastic Materials	3,229
2917 Naphtha	2,989
Total	33,198
Grand Total - All Traffic	215,430

SOURCE: Department of the Army, Corps of Engineers, Galveston District Office, Galveston, Texas.

areas, and is much less dense in the Matagorda Bay region. The main hub of crude oil lines in the study area centers around the city of Victoria, and the primary petrochemical pipelines lie along the Victoria Barge Canal servicing the chemical plants there.[6] Petrochemical lines supply ethylene, ethane, and ethane propane mix to the DuPont and Union Carbide plants. Union Carbide pipes propane to the National Starch plant. Big Three Company pipes nitrogen and oxygen to the DuPont plant.[7]

Numerous natural gas lines cross the area. Although there are a few minor companies, the primary supplier is the Houston Natural Gas Corporation. In addition, other lines are owned by the Dow Chemical Company, the Texas Eastern Transmission Corporation, and the Tennessee Gas Transmission Company.

The capacity of pipelines entering or leaving the Coastal Zone is sufficient to transport more than 150 million tons of crude oil and petroleum products each year.

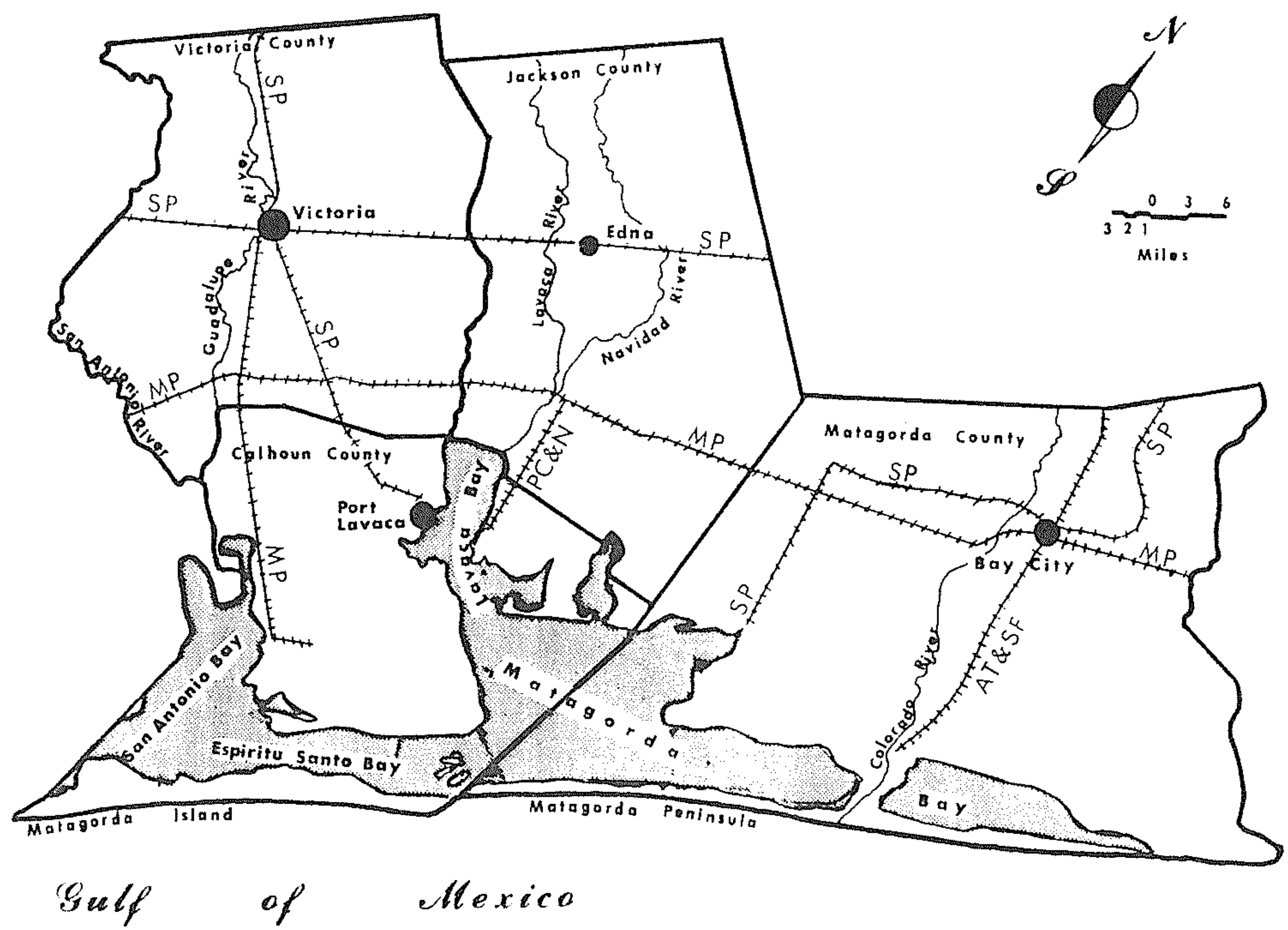
Rail Transportation

The Missouri Pacific, Southern Pacific, and the Santa Fe pass through Matagorda County. All three lines service Bay City, Southern Pacific has a terminal in Palacios, and Santa Fe has one in Matagorda. Within Bay City, Missouri Pacific has six daily freight stops, north and south, Santa Fe has two, and Southern Pacific, one.[8]

Calhoun County is served by the Southern Pacific, and both Calhoun and Jackson Counties are served by the Missouri Pacific, and the Point Comfort and Northern Railroad. The Southern Pacific Lines, formerly the Texas and New Orleans, has a mainline that extends from the West Coast through El Paso, San Antonio, Houston and New Orleans. A branch line extends from San Antonio through Victoria to Port Lavaca. The Missouri Pacific Lines extend from Brownsville in South Texas up the coast through Houston and Beaumont to New Orleans. A branch line from Bloomington terminates in Seadrift. The Point Comfort and Northern Railroad is a division of the Alton and Southern Railroad, which is a subsidiary of the Aluminum Company of America. The line consists of approximately eleven miles of track which extends from Lolita in Jackson County to the docks of the Port of Port Lavaca-Point Comfort and to the ALCOA facilities located nearby. This line exchanges with the Missouri Pacific Lines at Lolita.[9]

The Southern Pacific and Missouri Pacific Lines serve Victoria County. The city of Victoria is on the mainline of the Southern Pacific between Houston and the Rio Grande Valley. Outbound carload shipments, principally sand and gravel exceed inbound shipments at Victoria. The Missouri Pacific serves the city of Victoria from a branch line which extends from Bloomington, and provides daily service to the DuPont plant, and thrice-weekly service to the city. The Missouri Pacific Lines service includes public track delivery, unloading docks and store-door pickup and delivery service. The Southern Pacific Line service includes: five team tracks, house tracks with unloading docks, automobile platform, end unloading ramp for piggyback shipments and store-door pickup and delivery service.[10]

None of the rail corridors serving the Coastal Zone are operating at more than 20 percent of the basic capacity provided by the rail lines. Through signalization and centralized traffic control, present operations could be greatly increased. It has been suggested that more efficient rail line operations could be attained through consolidating traffic and eliminating duplicate facilities.[11] Figure 12 shows the routes for the various rail lines in the study area.



STUDY AREA RAIL LINES

FIGURE 12

Air Transportation

Air transport facilities in Matagorda County are provided by the cities of Palacios and Bay City. Bay City, in May 1970, opened their municipal airport. It has a 7,000 x 75 foot runway of which 5,120 feet is paved. The lighting system is Airport Medium Intensity lighting. It is located five miles east of the town on FM 2540. The airport is built with one main hangar and eleven smaller T-Hangars.[12] Palacios has fallen heir to Federal airport facilities which were built in conjunction with Camp Hullen. This facility includes three all-weather runways, each 5,000 feet long, and is FAA approved for commercial carriers and is currently serving as an alternate field for several air carrier lines.[13]

The only other airport of significance serving the region is the Victoria County Airport located 4 miles east of Victoria at Foster Field. This is the main air facility in the study area. Texas International Airlines serves this facility with two daily flights both ways to the new Houston Intercontinental Airport, and the Houston Metro Airlines provides five daily flights. The elevation at the airport is 116 feet above sea level. The airport contains three lighted, concrete runways: a 150 x 10,300 foot runway extends northwest to southeast, a 300 x 4,675 foot runway extends northwest to southeast, and a 300 x 4,600 foot runway extends northeast to southwest.[14]

In 1970, a total of 35,000 tons of goods were shipped from Coastal Zone airports. Although this is insignificant when compared to total traffic, some studies project that by 1990, one million tons of goods will be shipped from Coastal Zone airports.[15] Table 22 outlines 1970 data for Coastal Zone air cargo.

TABLE 22

AIR CARGO ORIGINATING AT COASTAL ZONE AIRPORTS IN 1970

AIRPORT	TONNAGE	PERCENT OF TOTAL
Beaumont-Port Arthur	518.4	1.5
Brownsville	180.2	.5
Corpus Christi	1,403.7	4.0
Galveston	34.0	0.1
Harlingen	213.3	0.6
Houston	32,515.3	92.4
Mission/McAllen/Edinburg	285.1	0.8
Victoria	22.5	0.1
Total	35,172.5	100.0

SOURCE: Transportation in the Texas Coastal Zone, prepared by the Texas Transportation Institute, Texas A&M University, 1973, College Station, Texas.

Highway Routes

Three State Highways cross Matagorda County: State Highways 35, 71 and 60. In the county are 99 miles of state highway, 196 miles of Farm-to-Market roads, and 500 miles of county roads.

Victoria is served by three U.S. highways: U.S. HIghway 87, U.S. Highway 77, and U.S. Highway 59. Portions of U.S. 59 have been reconstructed into what will eventually be the Houston to Brownsville Expressway. State Highways 185 and 175 are of significance, as 185 extends southeast and east to Seadrift and Port O'Connor, and a section of 175 is a link in the Houston to Brownsville Expressway. Numerous Farm-to-Market and County Roads also lie within the county.

U.S. Highway 87 extends into Calhoun County, from Victoria to Port Lavaca. State Highway 35 runs from Corpus Christi through Port Lavaca to Houston. Other State Highways lying within this county are 316, 238 and 185.

U.S. Highway 59, previously mentioned to be developed into the Houston to Brownsville Expressway, runs through Jackson County and the county seat of Edna. State Highways 172 and 111 also serve Jackson County. Numerous county and Farm-to-Market roads also afford county residents ease of travel.

An extensive network of 12,000 miles of freeways, highways, and Farm-to-Market roads crisscross the Coastal Zone. The average composition of vehicular traffic on rural highways in the Coastal Zone, which would apply to the study area, is as follows: passenger vehicles, 75 percent, pickups and panels, 13 percent, and motor trucks, 12 percent.[16]

Motor Freight

Matagorda County is served by six motor freight lines; they are as follows:

Alamo Express - through Bay City	one daily stop
Red Arrow - through Bay City	one daily stop
Merchants Fast Motor - through Bay City	one daily stop
Missouri Pacific Transport - through Bay City	one daily stop
Southern Pacific Transport - through Bay City	one daily stop
United Parcel Service - through Bay City	one daily stop

These six freight lines also serve Victoria, Jackson and Calhoun Counties with terminals in the city of Victoria, and with the Southern Pacific having an additional terminal in Port Lavaca.[17]

Considering Bay City as the point of departure or arrival, the time in transit for motor freight and rail to major cities in the Nation are shown in Table 23.

About two-thirds of the large motor trucks are loaded with an average of almost 10 tons of goods. The remaining one-third of the trucks are making empty back hauls. Examples of motor freight traffic in the Coastal Zone indicate that a total of 10.5 million tons of goods moves northwest out of Houston per year. Estimated rail traffic in the same corridor is 21 million tons. However, within the Rio Grande Valley, more goods are carried by truck than by rail. These estimates show the significance of truck transportation in the study area.[18]

The Influence of Marine Transportation on the Economic Development of the Study Area

In Texas Waterborne Commerce Commodity Flow Statistics, the following nine conclusions were outlined: (Annotations supplied by this author).

TABLE 23

RAIL - MOTOR FREIGHT TRANSIT TIME IN DAYS
FROM BAY CITY, TEXAS

DESTINATION	CARLOAD TRUCKLOAD		LESS THAN CARLOAD - TRUCKLOAD
	RAIL	MOTOR FREIGHT	MOTOR FREIGHT
Atlanta, Georgia	3	3	4
Charlotte, N. C.	4	4	5
Chicago, Illinois	3	3	4
Cleveland, Ohio	3	3	4
Dallas, Texas	1	12 hrs.	1
Denver, Colorado	2	2	5
Detroit, Michigan	3	3	4
Houston, Texas	12 hrs.	2 hrs.	12 hrs.
Los Angeles, Calif.	4	4	5
Memphis, Tenn.	3	3	4
Monterrey, Mexico	3	3	4
New Orleans, La.	2	2	3
New York, N. Y.	4	4	6
San Francisco, Cal.	4	4	5
St. Louis, Mo.	3	3	4
Seattle, Wash.	5	5	6
Little Rock, Ark.	2	2	2
Oklahoma City, Okla.	2	2	2
Montgomery, Ala.	3	3	3
Jackson, Miss.	2	2	3

SOURCE: Bay City Chamber of Commerce, Bay City, Texas.

1. "Texas is highly dependent on water transportation, especially as it serves the petroleum, chemical, agricultural and mineral related industries."

   The major employers in the study area, as listed in Tables 18 and 20, are involved in the processing of aluminum ores, the shipment of sand, gravel, crushed rock, and crude petroleum, and in the manufacture of chemical products. All of these industries are dependent on water transportation. Thus, it may be said that conclusion number 1 does apply to the study area in so far as it concerns the above mentioned industries. This conclusion, however, does not apply as well to Matagorda County, which in waterborne traffic has only 3.0 percent of the volume of the Matagorda and Victoria Channel traffic. At the present, Matagorda County is much more dependent on truck, pipeline, and rail transportation than water.

2. "Texas is a major trader with the hinterland via the intracoastal and inland waterway system. Significant volumes of commodities move between Texas and locations on the Mississippi, Ohio, and Illinois Rivers and segments of the intracoastal waterway. The Port of Chicago is one of the major receiving locations of Texas shipments while the segment of the intracoastal waterway between New Orleans and the Sabine River is a major originating area."

   Table 15 shows that the tonnage for the Matagorda and Victoria "internal" traffic amounts to only 4.2 percent of the state total. From confidential information received from questionnaires and interviews it has been estimated that the majority of this waterborne commerce stays within the state for further processing. This is primarily due to the large percentage of the total that is held by SIC 1442 (Sand, Gravel, and Crushed Rock), and the fact that this is shipped predominately to the

Houston area. Conclusion number 2 states that Texas is a major trader through the Intracoastal Canal and river systems with the U.S. hinterland. Expressed as a percentage of the state total, the study area's participation is very minor, possibly about 2 percent. Expressed, however, as a percentage of local traffic, the figure would be more substantial. It cannot be ascertained with great accuracy, but from Table 14, one can see that 47.66 percent of waterborne commerce is "internal." It has already been stated that the majority of that does not leave the state, and based upon this data, we might expect a maximum of 20 percent of the area's waterborne traffic to originate in or be destined for out-of-state locations.

3. "Texas' share of the waterborne commerce market has declined in recent years. The reasons for this decline are not available directly from the statistics. For this reason some state interest may be warranted."

   Table 15 indicated that the Victoria and Matagorda percentage of state traffic has from 1965 to 1970 increased from 2.92 percent to 3.24 percent, a 10.96 percent increase in those years. Thus, it may be said that while the Texas share of national waterborne commerce has dropped, the study area's share of Texas traffic has increased.

4. "Large volumes of waterborne traffic on the Texas section of the intracoastal waterway move entirely within the State."

   It has been stated that through confidential questionnaires and interviews, it has been estimated that the majority of the region's "internal" traffic does not leave the state. A minimum of possibly 28 percent of the study area's total water traffic originates along the barge canals within the state. This is primarily due to shipments of Sand, Gravel, and Crushed Rock outbound to the Houston area. Therefore, it may be said that conclusion number 4 is applicable to the Matagorda Bay region.

5. "Texas ships considerably more tonnage than it receives in both foreign and domestic coastwise trade. Although domestic internal receipts exceed shipments, the flow of commodities into and out of Texas on the intracoastal waterway has only minor imbalance."

   The fifth conclusion presented, cannot apply to the study area. Total waterborne imports equal 67.08 percent of this commerce, and exports equal 32.92 percent. This is based upon the 1970 data contained in Table 14. The reason is the large percentage of traffic which is inbound shipments of aluminum ores. Therefore, the Texas imbalance of significantly more total shipments than receipts is reversed in the study area.

6. "Crude petroleum is the major commodity entering and petroleum products are the major commodities leaving the State in domestic coastwise and internal trade."

   It can only be said that crude petroleum is the third most important export from the study area by domestic traffic, and is not an import. Major domestic imports into the region are primarily related to the chemical industry, specifically SIC's 2810 (Sodium Hydroxide), 2818 (Sulfuric Acid), and 2819 (Basic Chemicals and Products, nec). The significant domestic export by far is sand, gravel, and crushed rock, as was shown in Tables 18 and 20.

7. "Metallic ores and crude petroleum are the major commodities entering and farm products and chemicals the commodities leaving Texas in foreign commerce. These farm products moved to Texas ports by surface transport, largely from out of state."

   In foreign commerce, aluminum ores, SIC 1051, is almost the only import, and is the major item of trade in the region.

Foreign exports are few, with most of that lying in Basic Chemicals, SIC 2819. Thus, except in the case of SIC 1051, the region has a substantially different waterborne trade than the state.

8. "Total tonnage at Texas ports moving in foreign trade increased 4 million tons in 1970 over 1965 while domestic coastwise traffic declined by a corresponding amount during the same period. Traffic on the intracoastal waterway, however, increased by almost 8 million tons. Despite this absolute increase, Texas' share of foreign, domestic coastwise and internal tonnage declined relative to the rest of the Nation."

   It is interesting to note from conclusion 8, above, that Texas foreign trade increased by 4 million tons in 1970 over 1965, and from Table 16, it can be seen that the Matagorda ship channel accounted for 2,440,031 tons of this. Also, while Texas in this same period suffered a decline in domestic coastwise traffic, the Matagorda ship channel increased by 305 percent, although relatively minimal in quantity yet (Table 16). In regard to "internal" traffic, while Texas increased by almost 8 million tons from 1965 to 1970, the Matagorda and Victoria channels sustained a drop of 2,446,777 tons. However, in 1971, the Victoria Canal gained 908,224 tons to significantly offset that decline (Table 19).

9. "Several of the major ports in the State have serious traffic imbalances."

   Conclusion number 9, above, does apply to the Matagorda, Victoria and Colorado port facilities. Foreign imports completely dominate the Matagorda traffic, and internal shipments does the same for the Victoria Canal. The Colorado River traffic is about 86 percent internal receipts, also reflecting an imbalance of trade.

The capability exists to expand the use of the existing water routes in the study area. The limiting factors to water transportation at the present time are:

1. The lack of approved improvements to the Colorado River Channel from the Intracoastal Waterway to the Gulf, including jetties.
2. The barge traffic on the Intracoastal Canal passing through the Vermilion Lock in Louisiana encounters traffic jams. It is estimated that some barges have to wait 24 to 30 hours; this situation could pose a serious limiting factor on certain types of industrial development.

STRUCTURE OF THE ECONOMIC GROWTH

One method of analyzing economic growth patterns is to study historical shifts between types of economic activity. These sectors of economic activity are classified in this report as primary, secondary, and tertiary.

The primary sector includes those industries based on natural resources such as agriculture, forestry, fisheries, mining, etc. The secondary sector consists of those industries that "add value" to the natural resources through manufacturing, processing, and construction. The tertiary sector involves economic activity which provides services.

In general, the economy of an area first experiences economic growth based on primary sector activities. As industrial development becomes more advanced, the economic activity of the secondary sector will become the main source of earnings. Accompanying this growth will be additional demands for supporting services within the tertiary sector. Economic growth in the tertiary sector is often regarded as the key measure of material progress.

Tables 24 and 25 list the percentage of earnings and employment by each sector for the years 1967 and 1970. These data are also depicted on Figure 13.

Coastal zone data indicate nearly identical patterns for 1970 employment percentages as that of the state. However, the 6 percent difference in earnings of the secondary and tertiary sectors between the coastal zone and the state is probably a reflection of the vast numbers of manufacturing industies that have relied on waterborne transportation. Thus the coastal zone secondary earnings may remain proportionately higher than those of the state.

The Primary Sector

An analysis of mineral value, production and location was presented earlier, showing that of the total mineral value for each county, crude oil and natural gas production accounted for approximately the following percent:

CRUDE OIL AND NATURAL GAS PRODUCTION

Calhoun	=	66%
Jackson	=	100%
Matagorda	=	82%
Victoria	=	87%

This indicates that in those areas having a significant reliance on the primary sector of the economy, there is emphasis on industrial production of crude oil and natural gas, especially in Jackson and Matagorda Counties. Of the total 1971 mineral value for this four county region, 48 percent was found in Jackson County, 29 percent in Matagorda County, 12 percent in Calhoun County, and 11 percent in Victoria County.

Table 26 indicates total cash receipts from farm marketings for the state. As can be seen, the State of Texas experienced a downward trend in crop value, - 9.13 percent, while experiencing a 49.21 percent increase in

TABLE 24

PERCENTAGE EARNINGS AND PERCENTAGE EMPLOYMENT BY SECTOR - 1970

SECTOR	PRIMARY SECTOR PERCENT EARNINGS	PRIMARY SECTOR PERCENT EMPLOYMENT	SECONDARY SECTOR PERCENT EARNINGS	SECONDARY SECTOR PERCENT EMPLOYMENT	TERTIARY SECTOR PERCENT EARNINGS	TERTIARY SECTOR PERCENT EMPLOYMENT
Calhoun County	5	4	75	70	20	26
Jackson County	30	28	47	12	23	60
Matagorda County	38	20	18	20	44	60
Victoria County	14	6	30	26	56	68
Texas Coastal Zone	10	5	41	34	49	61
State of Texas	10	4	35	34	55	62

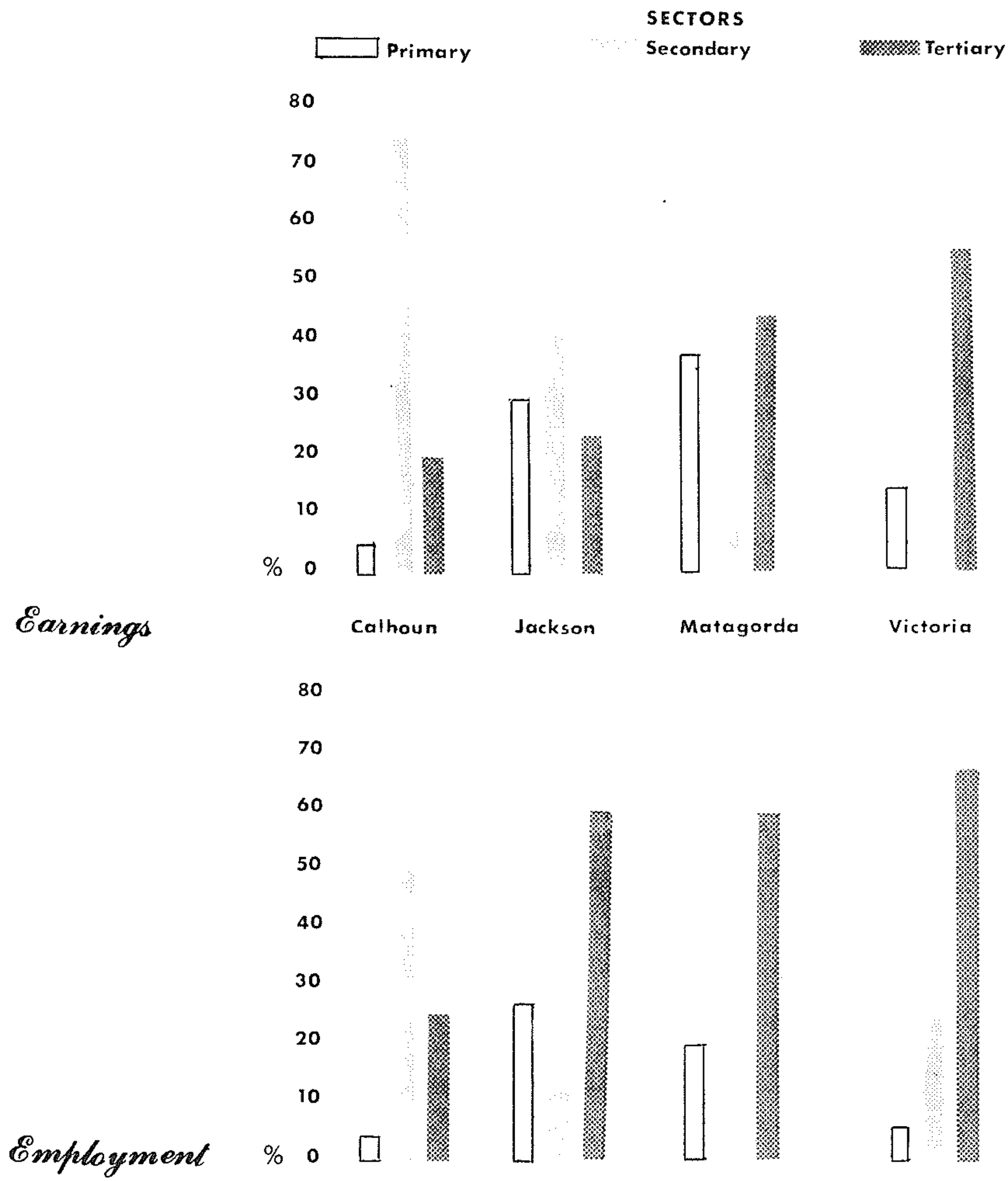
SOURCE: Dollar figures were obtained from County Business Patterns, Bureau of the Census, U.S. Department of Commerce, and the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C. Percentage figures were derived in the Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 25

PERCENTAGE EARNINGS AND PERCENTAGE EMPLOYMENT BY SECTOR - 1967

SECTOR	PRIMARY SECTOR PERCENT EARNINGS	PRIMARY SECTOR PERCENT EMPLOYMENT	SECONDARY SECTOR PERCENT EARNINGS	SECONDARY SECTOR PERCENT EMPLOYMENT	TERTIARY SECTOR PERCENT EARNINGS	TERTIARY SECTOR PERCENT EMPLOYMENT
Calhoun County	7	5	72	67	21	28
Jackson County	33	34	46	13	21	53
Matagorda County	37	20	21	16	42	64
Victoria County	12	7	39	33	41	60
Texas Coastal Zone	9	10	37	33	54	57
State of Texas	10	4	34	34	56	62

SOURCE: Dollar figures were obtained from <u>County Business Patterns</u>, Bureau of the Census, U.S. Department of Commerce, and the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C. Percentage figures were derived in the Industrial Economics Research Division, Texas A&M University, College Station, Texas.



EARNINGS & EMPLOYMENT BY
SECTOR BY COUNTY -- 1970

FIGURE 14

TABLE 26

TEXAS STATE TOTALS - CASH RECEIPTS FROM FARM MARKETINGS
($1,000)

ITEM	1968	1969	1970	1971
All Crops	1,246,010	1,122,738	1,261,393	1,132,267
Livestock and Livestock Products	1,421,911	1,782,523	1,956,233	2,121,595
Total Crops and Livestock	2,667,921	2,905,261	3,217,626	3,253,862
Government Payments	460,111	503,826	541,869	469,072
Total Farm Marketings and Government Payments	3,128,032	3,409,087	3,759,495	3,722,934

All Crops - Percent Change 1968-1971 = - 9.13
Livestock and Livestock Products - Percent Change 1968-1971 = + 49.21
Total Crops and Livestock - Percent Change 1968-1971 = + 21.96
Government Payments - Percent Change 1968-1971 = + 1.95

SOURCE: Texas County Statistics 1969 and 1971, compiled by the Texas Crop and Livestock Reporting Service, Austin, Texas.

livestock and livestock products. All four counties experienced similar trends in this time period, with Victoria County showing the greatest decrease in crop value, - 36.79 percent, and Calhoun County showing the greatest increase in livestock and livestock products, 57.01 percent.

To obtain a more up-to-date and detailed analysis of agricultural trends by county, the Texas Agricultural Extension Service of Texas A&M University compiles annual estimates of agricultural cash receipts by county by commodity, and offers projections for the coming year. These estimates are derived by each county agent with a board of farmers and ranchers.

Table 28 presents these data by county. The 1972 receipts depict a significant reversal in crop value. Calhoun and Victoria Counties show increases, as do Jackson and Matagorda Counties to a lesser degree. Calhoun County increases are due primarily to cotton and sorghum production. Victoria County crop value increases are reflected in cotton and rice production; Jackson County in rice, sorghum, and cotton; and Matagorda County in rice, cotton, and soybeans.

Total crop value in 1972 for the four county region was $42,725,000. Of this total, Calhoun County accounted for 11 percent, Jackson County, 35 percent, Matagorda County, 45 percent, and Victoria County, 9 percent. Livestock and livestock products, which included agricultural receipts from hunting and fishing, totaled $24,074,000. County percentages of this total are as follows:

Calhoun	=	11%
Jackson	=	26%
Matagorda	=	38%
Victoria	=	25%

Figure 14 represents crop and livestock value by county.

TABLE 28

AGRICULTURAL CASH RECEIPTS BY COUNTY

($1,000)

CALHOUN COUNTY

COMMODITY	1968-1969 AVERAGE	1970 ESTIMATED	1971 ESTIMATED	1972 ESTIMATED	1973 PROJECTED
03 Cotton	998.50	462.10	101.00	902.00	875.00
03 Cottonseed	76.00	71.10	15.00	88.50	120.00
13 Fish	0.00	0.00	0.00	1.00	1.00
13 Hunting	0.00	3.00	6.00	6.50	7.00
10 Other Beef	2,375.00	2,500.00	2,500.00	2,750.00	3,000.00
01 Rice	2,012.50	1,671.60	2,025.00	2,121.75	2,000.00
02 Sorghum	1,427.00	1,814.30	550.00	1,460.00	2,000.00
Total	6,889.00	6,522.10	5,197.00	7,329.75	8,003.00
All Crops	4,514.00	4,019.10	2,691.00	4,572.25	4,995.00
Livestock and Livestock Products, Hunting and Fishing	2,375.00	2,503.00	2,506.00	2,757.50	3,008.00
Total	6,889.00	6,522.10	5,197.00	7,329.75	8,003.00

Percentage Change 1968-1972	All Crops	Livestock, Etc.	Crops and Livestock, Etc.
	+ 1.2	+ 16	+ 6.4

TABLE 28 (Cont.)

AGRICULTURAL CASH RECEIPTS BY COUNTY

($1,000)

JACKSON COUNTY

COMMODITY	1968-1969 AVERAGE	1970 ESTIMATED	1971 ESTIMATED	1972 ESTIMATED	1973 PROJECTED
02 Corn	79.20	30.00	47.50	18.1	18.1
03 Cotton	353.55	292.50	455.00	858.7	928.7
93 Cottonseed	68.45	54.00	74.90	132.8	132.8
08 Eggs	44.80	47.70	0.00	11.6	12.0
10 Fed Beef	1,101.60	930.00	930.00	1,155.0	1,155.0
02 Hay	145.60	162.00	378.00	380.0	440.0
11 Hogs	130.35	163.70	108.60	122.4	100.0
13 Hunting	105.75	100.80	108.00	108.0	112.0
10 Other Beef	3,099.65	4,153.40	4,131.00	4,838.0	4,620.0
07 Other Crop	0.00	0.00	81.80	133.0	138.0
06 Pecans	60.00	0.00	0.00	120.0	60.0
01 Rice	7,337.25	7,642.50	9,631.10	10,420.6	10,420.6
02 Sorghum	1,701.60	2,942.50	2,117.50	2,743.1	2,743.1
12 Wool	1.85	1.50	0.80	.6	.6
11 Sheep	.00	.00	.00	2.5	2.5
Total	14,199.64	16,520.60	18,064.09	21,044.4	20,883.4
All Crops	9,715.65	11,123.50	12,786.60	14,806.30	14,881.30
Livestock and Livestock Products, Hunting and Fishing	4,484.00	5,397.10	5,278.30	6,238.10	6,002.10
Total	14,199.65	16,520.60	18,064.90	21,044.40	20,883.40

Percentage Change 1968-1972	All Crops	Livestock, Etc.	Crops and Livestock, Etc.
	+ 52.3	+ 39.1	+ 48.1

TABLE 28 (Cont.)

AGRICULTURAL CASH RECEIPTS BY COUNTY

($1,000)

MATAGORDA COUNTY

COMMODITY	1968-1969 AVERAGE	1970 ESTIMATED	1971 ESTIMATED	1972 ESTIMATED	1973 PROJECTED
02 Corn	66.00	68.90	43.00	54.00	50.00
03 Cotton	731.60	353.00	537.00	1,032.00	812.00
03 Cottonseed	120.50	54.00	46.00	126.00	112.00
08 Eggs	30.50	31.00	32.00	32.00	32.00
10 Fed Beef	566.00	570.00	575.00	0.00	0.00
02 Hay	263.00	255.00	336.00	306.00	336.00
11 Hogs	28.00	38.00	40.00	42.00	42.00
13 Horses	245.00	270.00	270.00	60.00	65.00
07 Nursery	1,195.50	1,400.00	1,475.00	2,100.00	2,380.00
10 Other Beef	7,576.50	7,750.00	7,775.00	9,000.00	9,050.00
01 Rice	12,994.00	11,500.00	12,390.00	12,920.00	14,250.00
02 Sorghum	839.50	2,080.00	2,052.00	2,109.00	2,339.00
04 Soybeans	26.50	5.00	84.00	551.00	1,021.00
05 Vegetables	13.00	12.00	13.00	14.00	14.00
06 Pecans	.00	.00	.00	65.00	65.00
Total	24,695.50	24,386.90	25,668.00	28,411.00	30,568.00
All Crops	16,249.50	15,727.90	16,976.00	19,277.00	21,379.00
Livestock and Livestock Products, Hunting and Fishing	8,446.00	8,659.00	8,692.00	9,134.00	9,189.00
Total	24,695.50	24,386.90	25,668.00	28,411.00	30,568.00

Percentage Change 1968-1972	All Crops	Livestock, Etc.	Crops and Livestock, Etc.
	+ 18.6	+ 8.1	+ 15

TABLE 28 (Cont.)

AGRICULTURAL CASH RECEIPTS BY COUNTY
($1,000)

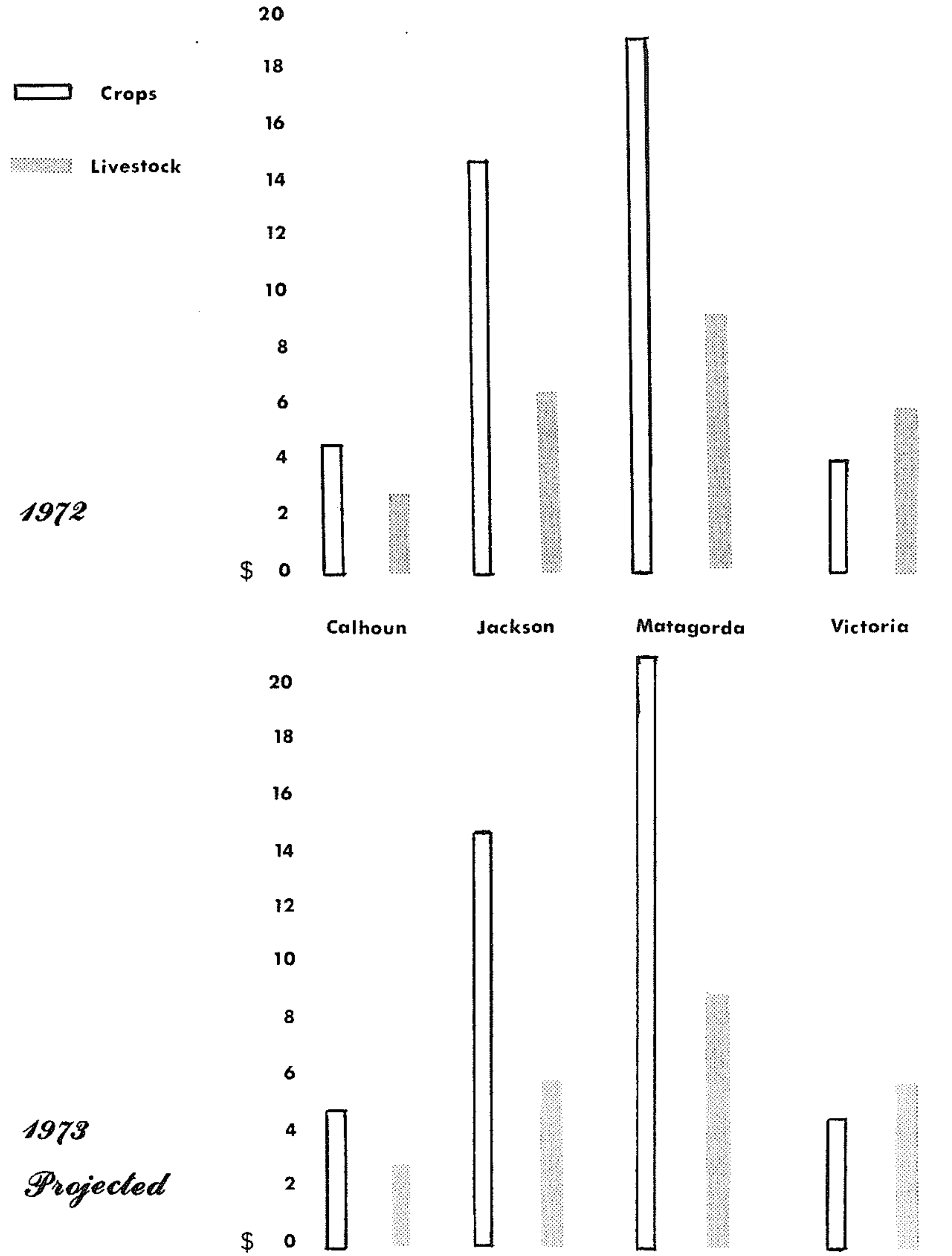
VICTORIA COUNTY

COMMODITY	1968-1969 AVERAGE	1970 ESTIMATED	1971 ESTIMATED	1972 ESTIMATED	1973 PROJECTED
02 Corn	121.00	437.00	90.00	200.00	220.00
03 Cotton	357.00	370.00	70.00	222.00	300.00
03 Cottonseed	69.00	34.00	7.00	28.00	35.00
08 Eggs	82.00	94.00	16.00	12.00	12.00
02 Hay	90.00	90.00	90.00	150.00	160.00
13 Hunting	10.00	10.00	10.00	12.00	12.00
10 Other Beef	4,411.00	4,320.00	4,800.00	6,700.00	5,700.00
06 Pecans	53.00	10.00	5.00	150.00	150.00
01 Rice	1,686.00	738.00	701.00	1,320.00	1,350.00
11 Sheef	13.00	10.00	10.00	10.00	10.00
02 Sorghum	1,841.50	1,850.00	1,232.00	2,000.00	2,000.00
08 Turkeys	18.00	8.00	60.00	60.00	60.00
12 Wool	5.00	1.50	1.50	1.00	1.00
Total	8,908.60	7,988.60	7,104.50	10,015.00	10,160.00
All Crops	4,217.50	3,529.00	2,195.00	4,070.00	4,205.00
Livestock and Livestock Products, Hunting and Fishing	4,691.00	4,459.50	4,909.50	5,945.00	5,955.00
Total	8,908.50	7,988.50	7,104.50	10,015.00	10,160.00

Percentage Change 1968-1972	All Crops	Livestock, Etc.	Crops and Livestock, Etc.
	- 3.5	+ 26.7	+ 12.4

Note: Table 30 identifies commodity classifications used on this table.

SOURCE: Texas Agriculture Extension Service, Texas A&M University, College Station, Texas.



CROP & LIVESTOCK RECEIPTS BY COUNTY ($000's)

FIGURE 14

Table 29 delineates commercial fish landing by State and District. Waterways included in the districts listed are as follows:

Aransas -	San Antonio Bay, Espiritu Santo Bay, Aransas Bay, Copano Bay, Corpus Christi Bay, and Nueces Bay.
Sabine -	Sabine Lake
Galveston -	Galveston Bay System (includes Trinity Bay).
Matagorda -	Matagorda Bay System (includes Lavaca Bay).
Laguna -	Laguna Madre and Baffin Bay.

In state fiscal year 1968, the Matagorda district accounted for approximately 8 percent of the total state fish landings, but dropped to approximately 6 percent in fiscal year 1972. Tables 29 and 30 show that most of the value of commercial fishing comes from shellfishing. In fiscal year 1968, 97 percent of the total value of Matagorda district landings resulted from shellfish landings, and 98 percent in 1972. Table 30 shows the most significant shellfish is shrimp.

Table 31 shows farm and mining earnings for each of the four counties, for the years 1940 through 1970. Victoria and Matagorda Counties show fairly equal distribution of primary sector earnings between the two types of activities.

<u>County Business Patterns</u> lists employment by primary industry for each of the four counties, for the first quarters of the years 1964, 1967, and 1970. From these data, it can be ascertained that employment in farming activities is negligible when compared to mining activities. This holds true apparently in all counties. SIC 1381, "Drilling Oil and Gas Wells," and SIC 1389, "Oil and Gas Field Services, N.E.C.," are the two major mining classifications with regard to employment.

TABLE 29

COMMERCIAL LANDINGS

	TOTAL FINFISH		TOTAL SHELLFISH		GRAND TOTAL	
	POUNDS	DOLLAR VALUE	POUNDS	DOLLAR VALUE	POUNDS	DOLLAR VALUE
From August 1, 1967 to September 31, 1968						
Texas Landings	38,076,195	1,714,538	84,237,471	41,768,363	122,313,666	43,482,901
Aransas District	1,169,674	256,669	22,257,741	11,141,358	23,427,415	11,398,027
Galveston District	1,583,305	246,071	26,265,746	12,752,099	27,849,051	12,988,169
Laguna District	2,506,488	612,773	25,881,954	13,906,682	28,388,442	14,519,455
Matagorda District	580,943	108,493	7,234,193	3,179,640	7,815,136	3,288,133
Sabine District	32,235,785	490,533	2,597,837	788,584	34,833,622	1,279,117
From August 1, 1968 to September 31, 1969						
Texas Landings	85,337,274	2,208,591	85,021,965	46,198,836	170,359,239	48,407,427
Aransas District	1,234,832	236,198	21,577,252	11,645,521	22,812,084	11,881,719
Galveston District	980,479	134,641	24,980,974	13,058,884	25,961,453	13,193,525
Laguna District	2,163,493	517,308	27,274,383	16,984,851	29,437,876	17,502,159
Matagorda District	578,286	104,398	8,662,447	3,677,116	9,240,733	3,781,515
Sabine District	80,380,184	1,216,045	2,526,909	832,463	82,907,093	2,048,508

TABLE 29 (Cont.)

COMMERCIAL LANDINGS

	TOTAL FINFISH		TOTAL SHELLFISH		GRAND TOTAL	
	POUNDS	DOLLAR VALUE	POUNDS	DOLLAR VALUE	POUNDS	DOLLAR VALUE
From August 1, 1969 to September 31, 1970						
Texas Landings	54,677,955	2,003,826	91,483,042	49,359,051	146,160,997	51,362,876
Aransas District	1,211,479	240,566	19,424,256	11,012,943	20,635,735	11,253,509
Galveston District	831,107	119,551	30,449,674	14,944,400	31,280,781	15,063,951
Laguna District	2,597,175	606,969	30,899,953	18,648,046	33,497,128	19,255,015
Matagorda District	554,968	97,501	7,257,657	3,502,784	7,812,625	3,600,285
Sabine District	49,483,226	939,239	3,451,502	1,250,877	52,934,728	2,190,116
From August 1, 1971 to September 31, 1972						
Texas Landings	11,168,900	1,804,343	110,277,447	83,976,375	121,446,407	85,780,719
Aransas District	1,503,819	392,167	27,791,308	22,276,814	29,295,127	22,668,981
Galveston District	951,110	187,421	32,775,651	23,857,715	33,726,761	24,045,136
Laguna District	3,718,094	970,720	37,488,258	30,357,652	41,206,352	31,328,374
Matagorda District	365,131	81,571	7,015,532	4,803,791	7,380,663	4,885,362
Sabine District	4,630,806	172,464	5,206,698	2,680,404	9,837,504	2,852,868

SOURCE: Annual Report, Respective Years, Texas Parks and Wildlife Dept., Austin, Texas.

TABLE 30

MATAGORDA DISTRICT LANDINGS

SPECIES	SEPT. 1, 1967-AUG. 31, 1968 POUNDS	DOLLAR VALUE	SEPT. 1, 1971-AUG. 31, 1972 POUNDS	DOLLAR VALUE
Cabio-Ling	10,544	$ 1,324	---	$ ---
Croaker	5,536	413	903	57
Drum-Black	66,041	5,505	57,179	7,142
Redfish	105,668	23,323	81,992	21,462
Flounder	57,295	12,901	30,104	8,749
Grouper	2,710	286	792	99
Whiting	9,915	518	400	28
Mullet	1,484	164	3,345	237
Pompano	25	8	438	154
Gafftop Catfish	25,408	1,603	7,250	525
Trout	228,274	48,911	147,834	38,795
Sheepshead	24,373	2,043	25,251	2,474
Snapper, Red	37,592	11,122	4,306	1,478
Unclassified	5,893	354	5,337	372
Crabs	726,691	58,353	827,487	84,244
Brown & Pink Shrimp	3,652,205	1,823,179	3,475,008	2,574,502
White Shrimp	2,535,370	1,166,481	2,415,165	1,978,206
Oysters	319,587	131,577	297,219	166,735
Squid	340	50	653	104

SOURCE: Annual Report, 1967-1968 and 1971-1972, Texas Parks and Wildlife Department, Austin, Texas.

TABLE 31

TOTAL EARNINGS FROM PRIMARY INDUSTRIES
($1,000)

CATEGORY	1940	1950	1959	1962	1965	1966	1967	1968	1969	1970
CALHOUN COUNTY										
Farm Earnings	557	2,620	1,921	2,294	4,080	3,624	2,913	3,164	4,823	2,688
Mining	67	338	1,252	733	284	283	544	1,061	292	280
Total	618	2,958	3,173	3,027	4,364	3,907	3,457	4,225	5,115	2,968
JACKSON COUNTY										
Farm Earnings	1,428	6,032	6,558	7,224	9,038	8,263	6,371	7,211	8,762	6,803
Mining	257	1,461	2,716	3,101	2,367	2,407	3,083	3,493	3,236	3,446
Total	1,685	7,493	9,274	10,325	11,405	10,670	9,454	10,704	11,998	10,249
MATAGORDA COUNTY										
Farm Earnings	1,489	9,085	9,900	11,074	13,019	11,715	9,321	9,011	12,316	9,768
Mining	491	2,456	5,968	6,502	7,824	7,994	6,720	6,771	6,191	9,263
Total	1,980	11,541	15,868	17,576	20,843	19,709	16,041	15,782	18,507	19,031
VICTORIA COUNTY										
Farm Earnings	2,006	5,147	3,829	4,527	6,141	5,863	4,693	5,269	6,418	6,571
Mining	76	656	2,393	4,819	5,797	5,772	6,276	6,279	6,084	6,469
Total	2,082	5,803	6,222	9,346	11,938	11,635	10,969	11,548	12,492	13,040

SOURCE: Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C.

The Secondary Economic Sector

Table 32 shows that manufacturing has produced significant earnings in the secondary sector in each of the four counties. County Business Patterns reaffirms this fact in terms of employment.

Tables 24 and 25 show that Calhoun County has had a great upsurge in secondary sector activities in an immediate area where the service of tertiary businesses have not yet been greatly affected. Tables 18 and 20 show that two basic industries have seen the stimuli for this activity: the aluminum industry (through the processing of aluminum ores) and the chemical industry, primarily SIC 2819 (Basic Chemicals and Products). Because 75 percent of earnings and 70 percent of employment are derived from the secondary sector, there is either a great potential for tertiary sector development, or the majority of employees reside in adjacent counties, thereby giving the benefit of their demand for services to areas outside Calhoun County. Calhoun County is, however, located near the two major ship channel entrances in the region, and there are still unexploited tertiary sector opportunities there.

Jackson County is relatively undeveloped in terms of industrial processes. Forty-seven percent of the county earnings, but only 12 percent of employment are in the secondary economic sector. In 1970, Jackson County reported only five manufacturing industies but Calhoun County reported 16; Matagorda County reported 18, and Victoria County had 38.

In Jackson County, farm earnings are about double that of mining activities in the primary sector (Table 31), and yet approximately 90 percent of this primary sector employment was in mining. Most of that employment lies within SIC's 1381, and 1389: "Drilling Oil and Gas Wells," and "Oil and Gas Field Services, N.E.C.," respectively. It may be seen that the large volume of earnings and low employment indicated in the secondary sector of

Jackson County can be attributed to oil and gas processing that requires little manpower (data from questionnaires returned from various oil and gas products industries in the area).

In the period 1964 to 1970 Matagorda County doubled its number of employees in manufacturing industies, and quadrupled its taxable payrolls. The number of employees in "contract construction" decreased. There are strong indications that secondary sector industries in Brazoria County employ a significant number of Matagorda County residents. These industries are not included in this study, but should be considered as affecting the potential industrial growth of Matagorda County. The Colorado Barge Channel also increases the potential of economic growth. Matagorda County's secondary sector earnings, as seen in Table 32, reflect a total decrease of 19 percent between 1965 and 1970. "Manufacturing" earnings rose by 22 percent in the same period, and taxable payrolls increased 350 percent from 1964 to 1970. Earnings increased by 22 percent from 1965 to 1970 and the manufacturing industries have expanded in Matagorda County; therefore, it is probable that continued growth in this sector can be anticipated.

Victoria County seems to have the most advanced economic status relative to the state and the coastal zone. Although it decreased in total earnings from 1965 to 1970, "contract construction," showed a 71 percent increase in taxable payrolls from 1964 to 1970. Taxable payrolls for "manufacturing" increased by 93 percent. The returned questionnaires from all secondary sector industries in Victoria County indicate approximately double the volume of present production is expected in the next ten years. Table 20 shows that the impact of the Victoria Barge Channel is significant. The chemical industry has expanded significantly and those industries related to the processing of, or services to the stone, sand, and gravel extraction business have been greatly aided by this means of transportation.

TABLE 32

TOTAL EARNINGS FROM SECONDARY INDUSTRIES
($1,000)

SECTOR	1940	1950	1959	1962	1965	1966	1967	1968	1969	1970
Calhoun County										
Manufacturing	107	4,765	16,342	19,954	23,027	26,009	26,751	28,389	32,417	35,795
Contract Construction	238	2,412	4,744	6,496	6,982	7,991	7,206	10,102	9,427	10,437
TOTAL	345	7,177	21,086	26,450	30,009	34,000	33,957	38,491	41,844	46,232
Jackson County										
Manufacturing	(D)*	(D)	(D)	(D)	(D)	9,324	10,118	10,938	11,421	12,562
Contract Construction	(D)	(D)	(D)	(D)	(D)	2,407	3,083	3,493	3,236	3,446
TOTAL						11,831	13,201	14,431	14,657	16,008
Matagorda County										
Manufacturing	99	513	749	1,224	5,648	6,371	6,129	(D)	6,816	6,888
Contract Construction	178	953	1,219	2,973	5,443	6,219	3,158	3,457	2,649	2,067
TOTAL	277	1,466	1,968	4,197	11,091	12,590	9,287		9,465	8,955
Victoria County										
Manufacturing	280	1,916	6,446	9,806	17,078	19,276	18,340	19,240	21,184	21,142
Contract Construction	242	2,492	3,946	5,267	9,439	10,728	16,577	13,246	7,685	7,232
TOTAL	522	4,408	10,392	15,073	26,507	30,094	34,917	32,486	28,869	28,374

* "D" indicates that data is withheld to avoid identifying the activities of specific industries.

SOURCE: Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C.

Table 33 lists the "value added" for manufacturing by county as compared to the state. This information added to that in Table 32 and employment data, helps to ascertain that Calhoun County is the leader in manufacturing industries, while Victoria County appears to have the most stable and broad based manufacturing segment of the economy. Jackson County appears to have the least developed secondary sector, and Matagorda County shows the most rapidly gorwing manufacturing sector.

The Tertiary Economic Sector

Tables 24 and 25 show that the tertiary sector development in Victoria and Matagorda Counties is the strongest in the four county region. In both cases, the demand for tertiary sector services has resulted from the influence of secondary sector industries in adjacent counties. The manufacturing industries in Calhoun County have created tertiary sector demands in Victoria County, as have those in Brazoria County impacted on Matagorda County. Jackson County has high employment in this economic sector, but a low percentage in sector earnings as compared to county totals. Calhoun County has a low rate of development in this sector. The major portion of the economic development in the tertiary sector has occurred within the fields of retail and wholesale trade.

Table 34 lists total earnings from the tertiary sector. All counties generally show steady increases, although in the case of Jackson County, the increases in earnings from wholesale and retail trade are very slow. Victoria County accounts for more retail and wholesale trade earnings than all other counties of the area combined. Retail sales estimates are listed on Table 35. While all other counties have indicated increases in retail trade from 1970 to 1971, Jackson County shows a decline. Calhoun

TABLE 35

VALUE ADDED BY THE MANUFACTURING SECTOR
($1,000)

YEAR	TEXAS	CALHOUN COUNTY	JACKSON COUNTY	MATAGORDA COUNTY	VICTORIA COUNTY
1967	10,922,400	W/H	W/H	20,700	52,700
Percent of State	100	---	---	0.18	0.48
1963	7,119,500	W/H	600	5,800	W/H
Percent of State	100	---	0.008	0.08	---
1958	5,045,159	W/H	W/H	1,192	33,886
Percent of State	100	---	---	0.02	0.67
1954	3,501,706	17,329	577	607	W/H
Percent of State	100	0.49	0.02	0.02	---
1947	1,727,464	W/H	246	1,622	1,322
Percent of State	100	---	0.01	0.09	0.08

* W/H indicates withheld to avoid disclosure.

SOURCE: Texas Almanac, Respective Years, A. H. Belo Corporation, Dallas, Texas.

TABLE 34

TOTAL EARNINGS FROM TERTIARY INDUSTRIES ($1000)

SECTOR	1940	1950	1959	1962	1965	1966	1967	1968	1969	1970
Calhoun County										
Wholesale and Retail Trade . . .	293	1,562	3,133	3,304	4,437	4,806	4,837	5,289	6,121	5,811
Transportation, Communication, Public Utilities . . .	45	265	481	568	880	949	982	982	1,033	2,009
Finance, Insurance, Real Estate . . .	32	219	655	841	520	562	607	707	682	734
Services . . .	123	542	1,638	1,632	2,054	2,215	2,715	2,954	3,555	3,503
Other	131	596	349	390	464	490	458	496	579	610
TOTAL	624	3,184	6,256	6,735	8,355	9,022	9,599	10,428	11,970	12,667
Jackson County										
Wholesale and Retail Trade . . .	261	985	1,735	1,820	2,465	2,654	2,312	2,435	2,557	2,865
Transportation, Communication, Public Utilities . . .	117	400	881	969	1,174	1,270	1,349	1,401	1,515	1,707
Finance, Insurance, Real Estate . . .	29	122	290	320	453	487	446	507	542	574
Services . . .	168	631	1,053	1,248	1,581	1,673	1,845	2,027	2,449	2,723
Other	4	32	50	62	87	91	158	176	196	178
TOTAL	579	2,170	4,009	4,419	5,760	6,175	6,110	6,546	7,259	8,047

TABLE 34 (Cont.)

TOTAL EARNINGS FROM TERTIARY INDUSTRIES ($1000)

SECTOR	1940	1950	1959	1962	1965	1966	1967	1968	1969	1970
Matagorda County										
Wholesale and Retail Trade . . .	1,277	4,165	5,761	6,737	8,033	8,685	8,641	9,303	9,584	9,656
Transportation, Communications, Public Utilities . . .	337	1,392	1,988	1,686	2,068	2,235	2,293	2,303	2,978	2,915
Finance, Insurance, Real Estate . . .	86	278	634	852	1,246	1,337	1,373	(D)*	1,693	1,813
Services . . .	856	2,456	3,830	4,429	4,903	5,265	5,895	6,072	6,875	7,208
Other	90	356	304	366	491	521	439	801	873	901
TOTAL	2,646	8,647	12,517	14,070	16,741	18,043	18,641		22,003	22,493
Victoria County										
Wholesale and Retail Trade . . .	1,501	6,492	12,157	13,763	16,431	17,836	17,989	19,475	20,836	21,808
Transportation, Communications, Public Utilities . . .	728	2,777	5,492	6,032	7,863	8,469	8,803	9,869	8,591	10,044
Finance, Insurance, Real Estate . . .	194	811	2,768	3,102	3,619	3,899	4,468	4,827	5,125	5,503
Services . . .	1,213	4,186	8,474	8,948	9,899	10,811	12,682	14,052	15,353	16,408
Other	40	79	183	267	431	473	340	225	229	264
TOTAL	3,676	14,345	29,074	32,112	38,243	41,488	44,282	48,448	50,134	54,027

* Excludes government earnings.

* "D" indicates that data is withheld to avoid identifying the activities of specific industries.

SOURCE: Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C.

TABLE 35

RETAIL SALES - ESTIMATES
1964, 1965, 1970, 1971

COUNTY	TOTAL RETAIL SALES ($1,000)	PERCENT OF TEXAS	FOOD ($1,000)	GENERAL MERCHANDISE ($1,000)	FURNITURE, HOUSING, APPLIANCES ($1,000)	AUTO-MOTIVE ($1,000)	DRUG ($1,000)	BUYING POWER INDEX
				1964				
Calhoun	16,901	0.13	6,558	1,416	798	1,640	771	.0077
Jackson	14,118	0.11	3,875	315	349	2,415	543	.0057
Matagorda	35,957	0.27	9,241	2,795	1,423	7,236	1,351	.0124
Victoria	70,841	0.53	17,637	9,966	3,757	13,487	2,274	.0239
Area Totals	137,817	1.04						
State Totals	13,303,043	100	3,029,398	1,946,091	576,932	2,827,898	464,163	4.9507
				1965				
Calhoun	18,802	0.13	7,196	1,618	860	1,940	867	.0077
Jackson	14,940	0.10	4,043	342	358	2,717	580	.0057
Matagorda	39,748	0.27	10,065	3,141	1,503	8,440	1,499	.0126
Victoria	78,449	0.54	19,117	10,568	4,012	15,833	2,529	.0244
Area Totals	151,939	1.04						
State Totals	14,628,228	100	3,266,501	2,177,558	607,087	3,277,399	511,555	4.9974

TABLE 35 (Cont.)

RETAIL SALES - ESTIMATES
1964, 1965, 1970, 1971

COUNTY	TOTAL RETAIL SALES ($1,000)	PERCENT OF TEXAS	FOOD ($1,000)	GENERAL MERCHANDISE ($1,000)	FURNITURE, HOUSING, APPLIANCES ($1,000)	AUTO-MOTIVE ($1,000)	DRUG ($1,000)	BUYING POWER INDEX
				1970				
Calhoun	28,854	0.15	9,761	2,429	799	5,470	1,025	.0078
Jackson	21,810	0.11	6,616	946	815	2,877	863	.0057
Matagorda	41,524	0.22	11,539	3,503	1,831	6,771	1,302	.0118
Victoria	91,653	0.48	25,968	14,012	4,442	16,275	2,687	.0241
Area Totals	183,841	0.95						
State Totals	19,279,604	100	4,263,451	3,408,499	814,015	3,780,755	664,772	5.2445
				1971				
Calhoun	34,507	0.16	11,505	3,007	916	7,355	1,250	.0077
Jackson	19,840	0.09	5,998	900	719	2,975	771	.0056
Matagorda	45,805	0.22	12,569	4,007	1,943	8,414	1,398	.0120
Victoria	107,442	0.57	29,728	16,845	4,952	21,255	3,031	.0248
Area Totals	207,594	0.98						
State Totals	21,123,656	100	4,567,811	3,797,747	848,322	4,599,906	698,420	5.2371

Note: Definitions of terms used in this table can be found in Definitions.

SOURCE: Sales Management, Survey of Buying Power, June 10, 1965, June 10, 1966, July 10, 1971, July 10, 1972, copyrighted, further reproduction not authorized.

County (Table 34) has decreased in wholesale and retail earnings in 1970; however, the 1971 retail sales estimates on Table 35 indicate an approximate 21 percent rise. Matagorda County has not shown any significant increases in wholesale and retail earnings, but has shown a sustained advance. Retail sales estimates when considered alone, however, show a more accelerated pace: approximately 29 percent from 1964 to 1971 and 10 percent from 1970 to 1971. Victoria County shows the most healthy economic climate for wholesale and retail trade. Earnings increased 5 percent from 1969 to 1970. Total retail sales estimates indicate a 53 percent increase from 1964 to 1971, and an 18 percent increase from 1970 to 1971.

Data listing employment by tertiary industries help to analyze more specifically the economic development of each of these counties. The taxable payrolls for wholesale and retail trade for each county from 1964 to 1971 fluctuated as follows:

Calhoun County:	Wholesale trade - 15.8 percent increase Retail trade - 54.1 percent increase
Jackson County:	Wholesale trade - 54.9 percent increase Retail trade - 42.3 percent increase
Matagorda County:	Wholesale trade - 19.0 percent increase Retail trade - 62.4 percent increase
Victoria County:	Wholesale trade - 48.2 percent increase Retail trade - 70.9 percent increase

Of the taxable payrolls for wholesale and retail trade in the first quarters in 1964 and 1970, each county accounted for the following percentages of the four county total:

	1964		1970	
County	Wholesale	Retail	Wholesale	Retail
Calhoun	11.8	12.3	9.4	11.5
Jackson	5.4	7.8	9.6	6.8
Matagorda	22.8	26.0	18.9	25.7
Victoria	60.0	53.9	62.1	56.0

Victoria County has undergone expansion in both categories for each year at the expense of every other county, with the one exception of the Jackson County wholesale trade.

The difference is even more marked in the "services" segment of the tertiary sector. Of the tertiary sector, "services" ranks closely behind "wholesale and retail trade" in both earnings and payrolls. "Services" includes such categories as motels, automobile repair, medical and legal services, laundries, beauty shops, etc. Taxable payrolls for each of the four counties totaled $3,201,000 for the first quarter of 1970. Of this total, Calhoun County accounted for 6.6 percent, Jackson County 4.3 percent, Matagorda County, 17.2 percent, and Victoria County, 71.9 percent.

The "finance, insurance, and real estate" part of the tertiary sector is important to the financing of local business. If it is possible to finance a business locally, this money will help to generate more money and feed the local economy; whereas if local business must leave the region to obtain financing, the local impact of the developing business is lessened. Earnings from "finance, insurance, and real estate" in 1970 totaled $8,624,000. Calhoun County accounted for 8.5 percent, Jackson County, 6.7 percent, Matagorda County, 21.0 percent, and Victoria County, 63.8 percent of the total. Taxable payrolls in the first quarter, 1970 indicated a total of $1,659,000 for the four counties. Of that, Calhoun County accounted for 8.6 percent, Jackson County, 5.5 percent, Matagorda County, 21.8 percent, and Victoria County, 64.1 percent.

"Transportation and other public utilities" are important measures of economic growth. This category includes trucking companies, gas companies, and electric companies, and it helps to complete a picture of the local economic growth.

Tertiary sector development based upon taxable payrolls and earnings is depicted on Figure 15.

Total earnings in 1970 in the industries included in "Transportation and Other Public Utilities" equaled $16,675,000 for all four counties. Total taxable payrolls for the first quarter, 1970, in the same region equalled $2,648,000. The percentages that each county shared in each of these totals are as follows:

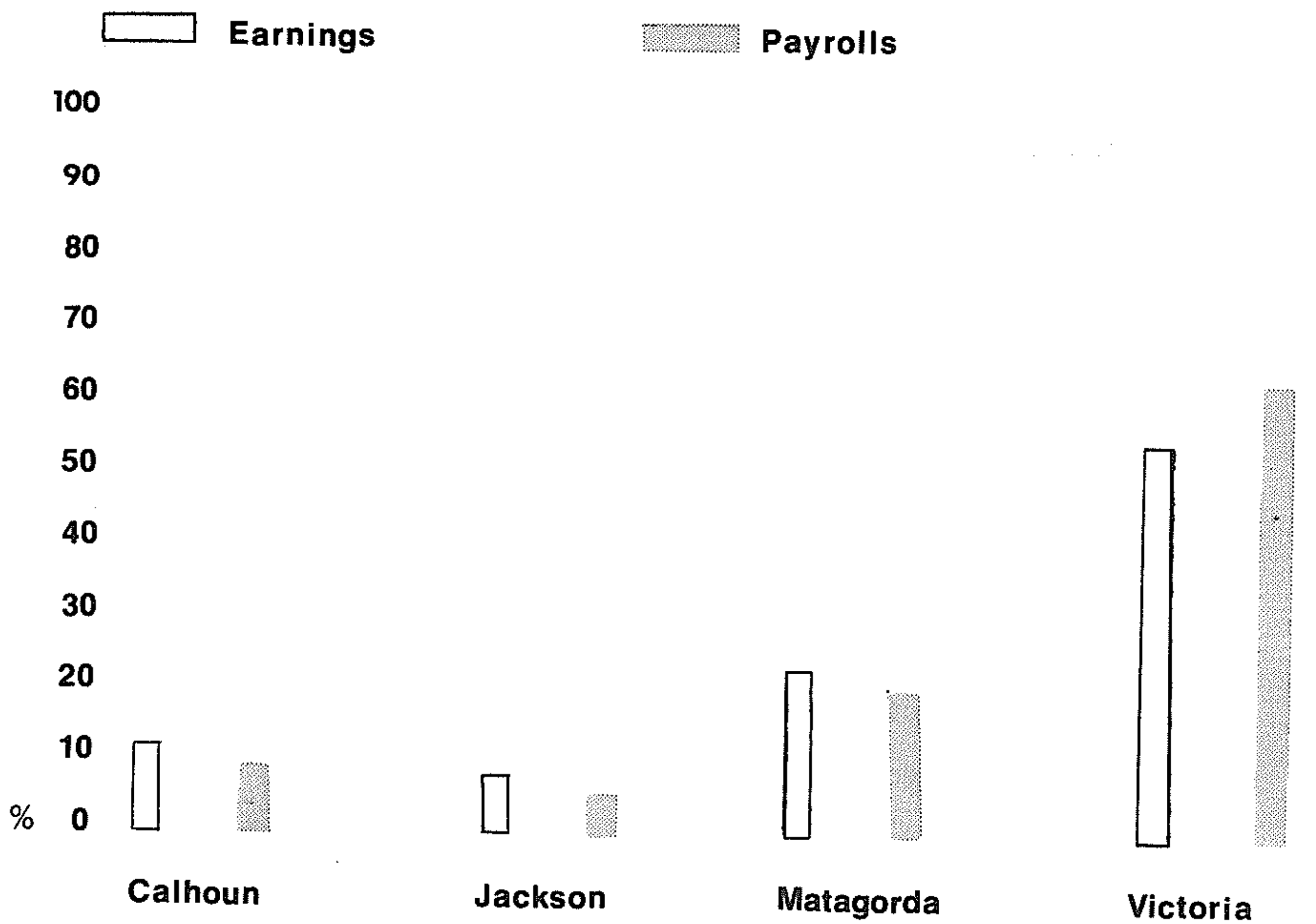
PERCENTAGE SHARE BY COUNTY

COUNTY	EARNINGS	TAXABLE PAYROLLS
Calhoun	12.1	9.1
Jackson	10.2	7.2
Matagorda	17.5	19.7
Victoria	60.2	70.0

If the tertiary sector is used as a measure of the sophistication and stability of each county's economy, the following chart can be drawn based on the year 1970:

COUNTY	EARNINGS	TAXABLE PAYROLLS
Victoria	55.6	63.7
Matagorda	23.1	20.3
Calhoun	13.0	9.5
Jackson	8.3	6.5

Thus, the economy of Victoria County is the most advanced in the region. Undoubtedly, Matagorda County leans toward the Houston-Galveston economic center more than in the direction of Victoria.



TERTIARY SECTOR IN 1970 OF THE
STUDY AREA BY COUNTY

FIGURE 16

CONCLUSIONS

Industrial Employment

One of the major employers in the study area and the prime user of waterborne trade in Calhoun County is the aluminum industry. Production facilities are located on a 3,000 acre tract at Point Comfort. It is appropriate to include a brief discussion of this industry.

During the 1960's aluminum shipments in the United States increased at an average annual compounded growth rate of 10 percent. The significant portion of these shipments was receipts from foreign countries and involved the import of alumina for processing. Primary production of aluminum in the United States increased during the past decade at an average annual compounded rate of 7 percent. U.S. Department of Commerce forecasts indicate a probable growth rate in primary production of about 7 percent per year to 1975.[19] It, however, is not expected to continue to grow at the 7 percent rate. Technological changes, particularly in the field of plastics, and higher energy costs will significantly impact upon the future of the aluminum industry. The U.S. Corps of Engineers has projected the following average annual growth rate for primary aluminum production in the United States:

AVERAGE ANNUAL GROWTH RATE

Years	Percent
1969-1980	6.56
1980-2000	4.85
2000-2020	4.00
2020-2025	4.00

These projections were made without the significant increases in present energy costs. The effect of these increased costs upon aluminum production has not been estimated for this study.

An additional variable is the world's potential reserves of bauxite. The U.S. Bureau of Mines reports that there exist 14,500 million tons of known bauxite reserves in the world, but that only 350 million tons are located within the United States. The Bureau of Mines goes on to state:

> One of the most serious problems confronting the domestic alumina producers is that of acquiring adequate and alternate sources of alumina-bearing materials for the continued use of an expanding industry and freeing the industry from uncertain foreign suppliers. This problem is further enlarged by the foreign governments which plan to improve their economy by processing indigenous minerals to a more advanced state. Thus in order to secure mineral rights the investing company often must also build an alumina plant, a smelter, and special facilities including electric power plants within the country.[20]

The U.S. Corps of Engineers has projected the physical production of primary aluminum in the United States per employee for the following years:

Year	Tons Per Employee
1975	170
1980	257
2000	451
2020	700
2025	752

Area population can reflect a picture of the area's economic development. Calhoun County has potential to reach the projected population figures and to exceed them, if the tertiary sector of the economy is able to benefit from the significant growth of the manufacturing industries.

Jackson County, on the other hand, appears to have a much more difficult situation in regard to population growth. Heavily dependent on primary sector businesses with minimal employment in the secondary sector, Jackson County may face serious problems in a declining population trend.

Matagorda County will probably have a population expansion because of the following contributing factors: proximity to the Houston-Galveston complex, ample water resources, availability of waterborne transportation, and strong tertiary and growing secondary sectors of the economy.

Victoria County is the hub of activity in this area located roughly half-way between Corpus Christi and Houston. This county will probably achieve the population projections, and in doing so it will be a major center for immigration.

The county seats will continue to gain population at the expense of the rural areas and smaller communities. This will be particularly true of the city of Victoria, where immigration will probably be heavier than in the remainder of the study area.

Mineral Resources

All four counties in 1971 experienced a decrease in total oil and gas value and production. Both production and the cash value of production decreased. This trend is likely to continue; but, sand and gravel will maintain their status as major mineral resources, particularly in the vicinity of the city of Victoria. There are indications that dredging for reef shell has decreased greatly. Total waterborne trade for the three area channels in SIC 0931, Marine Shells, unmanufactured, dropped from 655,079 tons in 1965 to 365,435 tons in 1971, a 44 percent decrease. All channels experienced similar declines in this commodity.

Generally, except within Calhoun County and the southeastern one-quarter of Jackson County, there should be adequate potable water supply for public and industrial uses for years to come. There is one belt of fresh ground water in Calhoun County that does supply fresh water for public and industrial consumption, and there is certain limited use of slightly saline ground water.

The two major factors that will influence the use of ground water are: 1) agricultural crop production, and 2) rainfall. Crop values for 1972 and projections for 1973 indicate significant gains over the declines of the past years. Because crop irrigation is by far the primary user of water, the relationship of ground water usage to the rate of recharge for this water is important. A study should be made to determine whether or not it is advisable to draw upon the ground water reserves beyond the recharge rate.

In summary, under current use patterns, no difficulties in utilizing ground water resources are likely. If, however, fresh water consumption increases at the same rate as over the past several years, shortages may be encountered.

Transportation

Questionnaire data indicate that no major lack in transportation modes appear to exist. This however, does not preclude the possibility of new industry deciding against locating in the study area due to transportation limitations. The city of Port Lavaca has expressed interest in better channel and docking facilities, and there has been concern over the limited availability of air transportation. Bay City officials expressed concern over the lack of appropriations for approved construction to improve the Colorado River traffic to the Gulf of Mexico. Otherwise the capability to expand the use of current modes of transportation is adequate.

Economic Structure

Data relating to earnings and employment by sector for the four-county study area are expressed below:

	Percent of Total Area	
	Earnings	Employment
Primary Sector	18.7	11.6
Secondary Sector	41.1	47.9
Tertiary Sector	40.2	40.5
	100.0	100.0

From Table 24 it can be seen that the region is more oriented toward the primary sector and less toward the tertiary sector of the economy than either the stste or the coastal zone. The secondary sector earnings are comparable to those of the state, while employment in this sector is still significantly high.

Considered as a whole, it might be expected that tertiary activity should gain both in earnings and employment, while the primary sector should evidence decreases. Primary sector percentage averages for the study area are expressed below.

	Earnings	Employment
Calhoun	6.6	7.5
Jackson	22.6	18.7
Matagorda	42.0	43.3
Victoria	28.8	30.5
	100.0	100.0

Agricultural earnings are approximately double those of mining activities in Jackson County and about ten times those of mining in Calhoun County. Matagorda and Victoria Counties exhibit an equal division between earnings of farming and mining activities. However, while agricultural activities hold such a significant position in relation to mining, approximately 95 percent of the study area's primary sector labor force is employed in the industries involved in extraction of the earth resources. With the 1972 trend in crop values, particularly rice production, we could expect to see increased farm earnings offset any continued downward trend in the value of mining activities. Of more concern, however, is the fact that approximately 95 percent of primary sector employment is engaged in activities which are declining. This is of local and regional concern.

Secondary sector percentage earnings and employment stated as a four-county total are as follows:

	Earnings	Employment
Calhoun	46.4	52.8
Jackson	16.1	1.9
Matagorda	9.0	11.8
Victoria	28.5	33.5
	100.0	100.0

These figures show the strong economic position of Calhoun County, in both manufacturing and contract construction. In 1970 Victoria County sustained a loss in employment within the secondary sector in both manufacturing and contract construction. However, this loss was balanced by gains in the tertiary sector. While Matagorda County indicates the lowest earnings within the secondary sector, other data indicate that this secondary sector is a viable factor in the county's economy. Forty-seven percent of Jackson County's earnings for 1970 are in the secondary sector.

	Earnings	Employment
Calhoun	13.0	9.5
Jackson	8.0	6.5
Matagorda	23.1	20.3
Victoria	55.6	63.7
	100.0	100.0

Victoria County appears as the most viable and growing economy in the region. Due to significant imbalances in the Calhoun County economy, this county's economic profile falls behind Matagorda County when viewed in respect to broad-based stability. Calhoun County should be able to expand upon it tertiary sector industries, if those who are employed in the secondary sector do not live in adjacent counties or in the case that they do, if they can be afforded attractive living environment within Calhoun County in order that they relocate.

Matagorda County appears to be making the transformation to a more sophisticated economy. Employment is increasing in all three sectors of the economy, but most significantly in the secondary sector. Any possible employment losses in mining activities will probably be gradual, and the county's economy should be viable enough to absorb the loss in the secondary and tertiary sectors.

Jackson County is encountering a more difficult situation. Heavily dependent upon the primary sector for employment and earnings, the county faces the likely possibility of decreased production in oil and gas fields. Tertiary sector employment is abnormally high for such limited earnings, and probably will be able to absorb little of the employment losses in the primary sector. The secondary sector appears unstable. Secondary sector earnings can expect to be reduced as the oil and gas extraction industry suffers declines. When viewed as one unit and compared to state and coastal zone figures, the four-county study area appears as follows:

Percentage Earnings -- 1970

	Study Area	Coastal Zone	State
Primary Sector	18.7	10	10
Secondary Sector	41.1	41	35
Tertiary Sector	40.2	49	55

Percentage Employment -- 1970

	Study Area	Coastal Zone	State
Primary Sector	11.6	5	4
Secondary Sector	47.9	34	34
Tertiary Sector	40.5	61	62

When expressed in terms of coastal zone and State figures, the following conditions may obtain in the study area:

1. Significant losses may occur in both earnings and employment in the primary sector, primarily in businesses linked to extraction of natural resources. Farm production indicates a continuing upward trend in livestock and livestock products, and a recent and significant upsurge in crop values. This agricultural production will not, however, offset the losses in mining.
2. Except for localized changes, it is possible that secondary sector growth will not show significant future gains. It may in fact exhibit a decline if technological advances which increase employee output continue.
3. It appears that the tertiary sector may undergo an increase, in both earnings and employment.

FOOTNOTES

1. Ground Water Resources of Matagorda County, Texas Water Development Board, p. 13, March, 1969, Austin, Texas.

2. Ibid, p. 38.

3. Transportation in the Texas Coastal Zone, prepared by the Texas Transportation Institute, Texas A&M University, 1973, pp. II-5, College Station, Texas.

4. Community Appraisal, Victoria and Victoria County, June, 1971, p. 3, The Fantus Company, New York, New York.

5. Rural Water and Sewer Comprehensive Plan for Matagorda County, 1970, p. 26, Edgar C. Barlow & Associates, Pasadena, Texas.

6. Transportation in the Texas Coastal Zone, op. cit., pp. IV-1t.

7. The Fantus Company, op. cit., p. 4.

8. Edgar C. Barlow & Associates, op. cit., p. 25.

9. An Industrial Facts Book of the Calhoun County Navigation District, April, 1969, pp. 5-1, 5-4, Industrial Economics Research Division, Texas A&M University, College Station, Texas.

10. An Industrial Facts Book, Victoria, Texas, 1967, pp. 5-1 - 5-4, Industrial Economics Research Division, Texas A&M University, College Station, Texas.

11. Transportation in the Texas Coastal Zone, op. cit., pp. IV-19.

12. Unpublished Bay City Chamber of Commerce Study, Bay City, Texas.

13. Edgar C. Barlow & Associates, _op. cit._, pp. 25-26.

14. An Industrial Facts Book, Victoria, Texas, _op. cit._, pp. 5-13, and telephone conversations with the pertinent airlines.

15. Transportation in the Texas Coastal Zone, _op. cit._, pp. IV-23.

16. _Ibid._, pp. IV-24.

17. Unpublished Bay City Chamber of Commerce Study, Bay City, Texas.

18. _Transportation in the Texas Coastal Zone_, _op. cit._, pp. IV-24.

19. _U.S. Industrial Outlook, 1970_, Business and Defense Services Administration, U.S. Department of Commerce, December, 1969, pages 205-207, Washington, D.C.

20. Bulletin 630, Mineral Facts and Problems, U.S. Bureau of Mines, 1965, p. 21, Department of the Interior, Washington, D.C.

BIBLIOGRAPHY

Annual Report, 1967-1968, and 1971-1972, Texas Parks and Wildlife Department, Austin, Texas.

Annual reports of county agricultural cash receipts prepared by the Agricultural Extension Service, Texas A&M University, College Station, Texas.

Community Appraisal, Victoria and Victoria County, The Fantus Company, New York, New York, June, 1971.

Computer print outs with data from the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C.

County Business Patterns, 1964, 1967, and 1970, U.S. Department of Commerce, Bureau of the Census, Washington, D.C.

Economic Development and Factors Affecting Industrial Location on the Texas Gulf Coast, Industrial Economics Research Division, Texas A&M University, College Station, Texas, March, 1973.

An Economic Feasibility Study for the Future Expansion of the Port of Port Lavaca-Point Comfort, Industrial Economics Research Division, Texas A&M University, College Station, Texas, 1969.

Ground Water Resources of Matagorda County, Texas Water Development Board, March, 1969, Austin, Texas.

Ground Water Resources in the Vicinity of Palmetto Bend Reservoir, Unpublished, Texas Water Development Board, Austin, Texas.

An Industrial Facts Book of the Calhoun County Navigation District, Industrial Economics Research Division, Texas A&M University, College Station, Texas, April, 1969.

An Industrial Facts Book, Victoria, Texas, Industrial Economics Research Division, Texas A&M University, College Station, Texas, August, 1967.

Matagorda Ship Channel, Navigation Area Economic Study, Unpublished, U.S. Corps of Engineers, Galveston District Office, Galveston, Texas.

Mineral Facts and Problems, Bulletin 630, U.S. Bureau of Mines, Department of the Interior, Washington, D.C., 1965.

Rural Water and Sewer Comprehensive Plan for Matagorda County, Edgar C. Barlow & Associates, Pasadena, Texas, 1970.

Stieghorts, Junann J., _Bay City and Matagorda County_, Pemberton Press, Austin, Texas, 1965.

Talley, Claude A., Jr., _Water and Sewer Plan for the Golden Crescent_, Council of Governments, Economic Conditions Study, Victoria, Texas, 1972.

Taylor, I.T., _The Cavalcade of Jackson County_, The Naylor Co., San Antonio, Texas, 1938.

Texas Coastal Basins, Interim Report, U.S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas, January, 1972.

Texas County Statistics, 1969 and 1971, Texas Crop and Livestock Service, Austin, Texas.

Texas Waterborne Commerce Commodity Flow Statistics, Texas Transportation Institute, Texas A&M University, College Station, Texas, 1973.

Transportation in the Texas Coastal Zone, Texas Transportation Institute, Texas A&M University, College Station, Texas, 1973.

APPENDIX

Definitions

S.I.C.

"S.I.C." is the abbreviation used in this report to refer to "Standard Industrial Classification." It is prepared by the Statistical Policy Division of the Office of Management and Budget, Executive Office of the President.

The Standard Industrial Classification was developed for use in the classification of establishments by type of activity in which they are engaged, thus facilitating the collection, tabulation, uniformity, comparability, presentation and analysis of data relating to these establishments. Each establishment is assigned an industry code on the basis of its major activity, which is determined by the product or group of products produced or handled, or services rendered. The structure of the Classification makes it possible to classify establishments by industry on a two-digit, a three-digit, or a four-digit basis, according to the degree of detail in information which may be needed.

An example is as follows:

Division A: Agriculture, Forestry, and Fishing

Major Group 01: Agricultural Production - Crops

Group No.	Industry No.	
011		Cash Grains
	0111	Wheat
	0112	Rice
	0115	Corn
	0116	Soybeans
	0117	Cash Grains, Not Elsewhere Classified

N.E.C. or nec

"N.E.C." is an abbreviation representing "Not Elsewhere Classified," as used in SIC 0119 that has been used as the example in the definition of S.I.C.

Terms Used on Table 34

BUYING POWER INDEX (BPI): This is a weighted index that converts three basic elements - population, Effective Buying Income and retail sales - into a measurement of a market's ability to buy, and expresses it as a percentage of the U.S. potential. It is calculated by giving a weight of 5 to the market's percent of the U.S. Effective Buying Income, 3 to its percent of U.S. retail sales, and 2 to its percent of U.S. population. The total of these weighted percents is then divided by 10 to arrive at the BPI.

DRUG STORES AND PROPRIETARY STORES (SIC 591): The column "Drug" in the Survey tables includes both Drug Stores and Proprietary Stores. Drug stores fill and sell prescriptions. Proprietary stores do not. Both sell drugs, proprietary medicines and other health and first aid products, as well as a variety of other merchandise - cosmetics, toiletries, candy, tobacco products, magazines, toys, etc.

FOOD STORES (SIC MAJOR GROUP 54): Food stores are establishments primarily selling food for home preparation and consumption. The definition embraces grocery stores, meat markets, fish markets, fruit and vegetable markets. Also included are candy, nut and confectionary stores, dairy product stores, retail bakeries, and egg and poultry dealers.

FURNITURE, HOME FURNISHINGS AND EQUIPMENT STORES (SIC MAJOR GROUP 57): This major store category is really a combination of several sub-groups. The first, furniture-home furnishing stores, primarily sell merchandise used in furnishing the home - furniture, floor coverings, draperies, curtains, upholstery, china, glassware, metalware, and miscellaneous home furnishings. The other major subgroups are household appliance stores, radio and television stores and music stores.

GENERAL MERCHANDISE STORES "SIC MAJOR GROUP 53, EXCEPT "NONSTORE RETAILERS"): This includes department stores, limited-price variety stores (the "5 & 10's"), general merchandise stores, dry good stores, and sewing and needlework stores.

AUTOMOTIVE DEALERS (SIC MAJOR GROUP 55 EXCEPT 554): Included in this group are retail outlets selling cars - domestic, imported, new, and used. These dealers nationally account for about 90 percent of the automotive group total sales. Sales by the second most important subgroup, dealers selling tires, batteries and accessories, account for about 8 percent of the group total. Motorcycle dealers, household trailer dealers, boat dealers, and "other" automotive dealers (bicycle shops, for example) round out the group.

PERCENT OF U.S.A.: A measure of a market's share of the total U.S. population, income or retail sales.

Rail Line Abbreviations

M.P. - Missouri Pacific

S.P. - Southern Pacific

P.C. & N. - Point Comfort and Northern

A.T. & S.F. - Atchison, Topeka, and Santa Fe

M.K.T. - Missouri, Kansas, and Texas