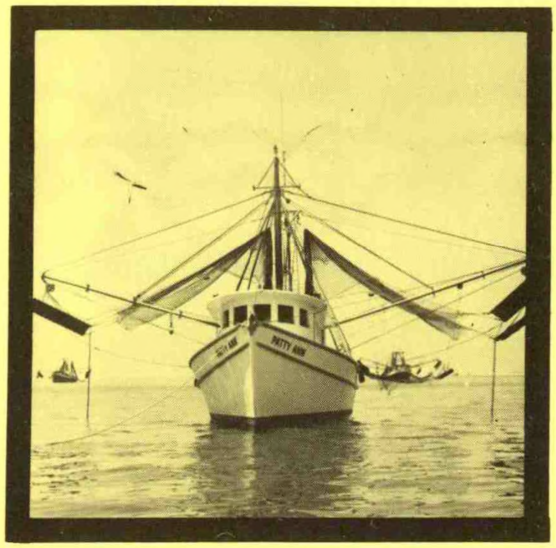
Marine Environmental Assessment

GULF OF MEXICO

1985 ANNUAL SUMMARY



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Assessment and Information Services Center

CLIMATE IMPACT ASSESSMENT
UNITED STATES

The AISC/Marine Environmental Assessment Division (MEAD), Marine Assessment Branch (MAB), produces periodic assessments of environmental impacts on economic sectors of marine-related activities. Since 1981, MAB has issued assessments of Chesapeake Bay in the economic sectors of fisheries, recreation, and transportation. For the Chesapeake Bay region, which served as a model for assessment development, there are now quarterly and annual issues. Also available are annual assessments for San Francisco Bay and Puget Sound. This is the fourth in the series of annual assessments for the Gulf of Mexico.

Please send comments or subscription queries to the Chief, Marine Assessment Branch, Marine Environmental Assessment Division, NOAA/NESDIS/AISC, E/AI32, 1825 Connecticut Avenue, NW, Washington, DC, 20009, or call (202) 673-5400.

Front Cover Photographs

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Beach Scene - EPA Documerica - Hope Alexander
Gulf Coast Seashore - National Park Service
Shrimp Boat - NOAA File Photo

December 1986

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
Washington, D.C. 20233

Assessment and Information Services Center

February 6, 1987 E/AI32:ICS

Dear Colleague:

The Marine Environmental Assessment Division of NOAA's Assessment and Information Services Center (AISC) produces periodic assessments of environmental impacts on economic sectors of marine-related activities. The Chesapeake Bay region served as the first area for AISC assessment development since 1981, and this service has been extended to cover other marine areas. Annual Summaries covering the Gulf of Mexico have been published for 1982, 1983, and 1984.

We are pleased to send you the enclosed complimentary copy of the Gulf of Mexico 1985 Annual Summary. The Annual Summary includes information on weather, oceanography, fisheries, recreation, transportation, pollution, and special events affecting the Gulf region. The report focuses on the effects of environmental events on economic sectors, providing a multidisciplinary view of the Gulf and its use.

Diverse groups and individuals contributed to the preparation and review of the assessment and we are providing copies to those persons on an exchange basis. The assessment is also available each year to others at $4.00 per issue. Information on subscribing to future issues is included in the package.

Please send any comments or suggestions on the assessment directly to the Project Manager for the Gulf of Mexico Assessment, Karl B. Pechmann, at the following address: NOAA/NESDIS/AISC -- E/AI32, 520 Universal Building, 1825 Connecticut Avenue, N.W., Washington, D.C. 20235; telephone (202) 673-5400.

Sincerely,

Robert E Dennis

Robert E. Dennis
Chief, Marine Assessment Branch
Marine Environmental Assessment Division

Enclosures (2)

A subscription to receive the publication,

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Marine Environmental Assessment

GULF OF MEXICO
1985 ANNUAL SUMMARY

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Washington, D.C.
December 1986

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GULF OF MEXICO MARINE ENVIRONMENT
1985 ANNUAL SUMMARY

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SECTION 1

INTRODUCTION

The Gulf of Mexico 1985 Annual Assessment presents a synoptic view of several economic sectors and their direct and indirect relations to the physical and biological aspects of the marine and atmospheric environments. We attempt to bring into a single focus the numerous commercial, social, and scientific activities in the Gulf relative to environmental conditions, especially weather and oceanographic events or trends. Using time series data from physical oceanography, marine biology, meteorology, political science, and economics, we have developed a multi-disciplinary view of the Gulf during a single calendar year.

Assessment of the economic impacts of weather and environment is important to planners, engineers, scientists, and commercial interests because of heavy multiple-use requirements of the coastal zone. Our population relies on the nearshore estuarine and coastal shelf environment for food, recreation, energy, transportation, and industrial and societal waste disposal. Many uses conflict at some level of activity. Furthermore, the relative impacts and conflicts are often sensitive to weather and climate.

The measurement of impacts is imprecise. Specification of relationships between exogenous variables (weather, ocean conditions, catch statistics) and economic sector variables (transportation, pollution costs, fishery market dynamics) requires further investigation. In this publication we bring together data from several economic sectors and environmental disciplines. No attempt is made to limit data to specific models or preconceived ideas of causal relationships. Where direct relationships are unclear, the presentation of data from several scientific and economic areas has value by displaying the multiple use of the Gulf coastal region.

By presenting this collection of data, we intend to stimulate further investigation by scientists and to provide information to those persons responsible for usage regulations of the Gulf and its estuaries.

1.1 Organization of the Report

The report is comprised of seven sections. In the introductory section we define the concept of an assessment as embodied in this report, specify the coverage of the present report, and suggest areas of extension and future development.

In section 2 we present a summary of impacts we have identified for 1985.

Sections 3 through 6 contain details of the weather and ocean conditions, fisheries, recreation, and transportation in the Gulf of Mexico marine environment for 1985. Discussions in these sections cover all information that has been received by the Marine Assessment Branch at this time. The review gives a limited synoptic view of the above sectors and their interrelationships for a single year.

Section 7 contains a discussion of a selected environmental issue in the Gulf. This discussion concerns the disposition of abandoned offshore oil and gas platforms. Although this might not be directly pertinent to an assessment of the environmental events of 1985, it has a strong potential impact on the marine environment.

1.2 Scope of the Report.

The geographical area considered is that part of the Gulf of Mexico that lies north of an imaginary line extending from Brownsville, Texas, to Key West, Florida.

We present a summary of weather and oceanographic events during 1985 over the region, though environmental cycles vary in different regions of the Gulf. Discussion will indicate where such environmental variability is important. The calendar year serves the assessment function in tracking economic variables. Where discussion of environmental patterns or events requires reference to 1984 or 1986, we extend coverage.

Three economic sectors appear in this report: fisheries, recreation, and transportation. The fisheries section covers finfish and shellfish. Distribution and abundance of species are influenced by local and regional regimes of salinity and temperature.

The changing regimes of salinity and water temperature in turn are related to precipitation, air temperature, and general coastal conditions over a broad span of space and time. Harvest of commercial species varies with climatic conditions, fishing effort, and market conditions. Tributaries of the Gulf form a large resource for waste disposal for surrounding industry and populations. Because of this, streamflow and water quality are factors that affect the fishery distribution. The transportation sector affects the distribution of the fisheries species as well as harvest activity.

Recreation includes park usage, boating, recreational accident statistics, and human interactions with wildlife. The recreation sector responds rapidly to weather variations and correlates with pollution incidents and the presence of annoying or dangerous organisms in the water. The Gulf coast is used heavily for recreational activities that include swimming, boating, fishing, and tourism.

The transportation sector includes shipping and related shore activity. Through most months of the year shipping and related shore activities remain unaffected by climate and weather. Only tropical storms or severe cyclones interrupt normal marine transportation in the Gulf.

1.3 Future Work

The Assessment and Information Services Center, Marine Environmental Assessment Division recognizes the need for extension of this assessment to other sectors and more detailed and rigorous analyses of those sectors already discussed. The industrial complex surrounding the Gulf includes heavy manufacturing (steel, automobiles), food processing (spices, sugar), refining, shipbuilding, and chemical production. The use of water in each of these industries contributes to the quality of water entering the Gulf coast estuaries.

Future work in the recreation sector might include assessment of marina usage and sales of recreational equipment.

In transportation a study of the detailed distribution of Search and Rescue (SAR) operations in categories of damage, injury, cost, and geography will enhance the usefulness of this assessment.

Table 2.1--Summary of storm events and impacts, Gulf of Mexico, 1985.

Date	Storm Event	Impacts
January 19-23	Cold wave (LA, MS, AL FL)	14 people killed, damage to property (fires, frozen pipes) and crops extensive, e.g. two-thirds of FL veg. crop was lost (>$10.0 million total) one-third of grazing land
February 1, 2	Winter storm (AL, MS, LA)	Property and crop damage due to frozen precipitation and snow (property >$5.0 million, crop >$0.5 million)
March 17	Tornado (FL)	2 deaths, injuries, property damage (>$5.0 million)
April 5	Thunderstorms, tornadoes (AL, LA)	Injuries and property damage (>$0.5 million) from a rash of storms in LA and AL
May 21	Thunderstorms, winds (LA)	2 deaths, injuries and property damage (<$0.5 million) including boats
28	Thunderstorm winds (north MS)	Injuries, property, crop damage (>$0.5 million)
June 1-7	Heat wave (AL, FL, GA, MS)	12 deaths, injuries, agriculture losses (crop, chickens) (>$1.0 million)
5, 6	Flash flooding (TX)	2 deaths, property and crop damage (San Antonio area) (>$2.0 million)
July 1	Thunderstorm, winds, hail (central MS)	Property and crop damage due to golf- to tennis-ball sized hail (>$0.5 million)
5, 6	Flash flooding (MS)	Property damage (Gulfport area) (>$0.5 million)
24	Flash flooding (AL)	Property damage (NE Alabama) (>$0.5 million)
August 15	Hurricane Danny (LA, MS)	Injuries, property, and crop damage (Total ~$50.0 million, crops >$10.0 million, property >$10.0 million)
16	Tornadoes (north AL)	1 death, injuries, and property damage (>$2.0 million)
September 2	Hurricane Elena (LA, AL, MS)	Injuries, property, and crop damage. Wind damage (Total ~$1.25 billion, >$1.0 billion property, >$0.5 million crop)
30	Flooding (south TX)	Property damage (>$0.5 million)
October 28-31	Hurricane Juan (LA, AL, MS, TX) flooding, wind	11 deaths, injuries, property, and crop damage from heavy rains (Total ~$1.5 billion, >$300 million property, >$250 million crop)
28	Tornadoes (west FL)	Injuries, property damage. (>$1.0 million)
November 21	Hurricane Kate (FL)	One death, injuries, property, and crop damage (Total $300 million)
11	Flooding (southeast TX)	Property damage (>$0.5 million)
24	Flooding (south-central, southeast TX)	One death, property damage (>$3.0 million
December 1	Thunderstorm winds (LA, TX, MS, AL)	49 reports of damaging winds in this 4 state area; injuries, property damage
10	Tornadoes (TX)	Injuries, property damage (>$0.6 million)

Data from Storm data, January through December 1985. U.S. Department of Commerce, NOAA, National Climatic Data Center.

SECTION 2

IMPACT SUMMARY

Weather and Oceanography

Four hurricanes and one tropical storm struck the Gulf of Mexico in 1985. Of these events, Hurricane Juan caused the most damage. Winds, storm surge, and heavy precipitation resulted in damages exceeding $1.5 billion. Elena, with wind speeds greater than 125 miles per hour, caused more than $1 billion in damage. Although the other two hurricanes, Kate and Danny, were less destructive than either Juan or Elena, they produced damages in excess of $65 million.

Temperature extremes also affected the Gulf area in 1985. A cold wave in January swept across the Gulf from Louisiana eastward causing extensive damage and 14 deaths. Conversely, a heat wave in early June caused 12 deaths in the eastern Gulf region. Table 2-1 gives a chronological list of weather events and impacts for 1985.

Fisheries

The Gulf of Mexico fishery yielded the nation's largest harvest by weight for the third consecutive year. More than 2.4 billion pounds of finfish and shellfish, valued at more than $590 million. These landings were lower than 1984's by 200 million pounds and $65 million. The Gulf region accounted for 38.1 percent by weight and 25.8 percent by value of the national landings.

Total finfish landings were down from 1984. The difference can be directly attributed to the lower menhaden harvest that fell below record level landings set in 1984. Total shellfish landings were the same as in 1984, although the value decreased by $50 million. This was due to an overall lower price per pound paid for the shrimp and a decrease in the Texas landings of 7 million pounds. The Texas shrimp were smaller than expected due to their leaving the estuaries sooner than normal. This was partially due to above-normal streamflow that altered the regimes of temperature and salinity, and the shrimp migrated, seeking their preferred regimes.

Recreation

National and state park visits, boating registrations, search and rescue operations, recreational fishing participation and fish catch, wildlife refuge visits, and hunting license/stamp purchases are included in a series of indicators of economic values of recreation around the Gulf of Mexico. A comparison of these indicators for 1985 with those of 1984 showed that all indicators, except state park visits, rose.

Transportation

Total tonnage handled in 1985 at the seven major ports addressed in this report declined from tonnage levels in 1984. Tonnage at five of ports decreased, at one of the ports was unchanged, and at the other port increased slightly.

In an effort to deepen ship channels to accomodate larger vessels and, hence, lower transportation costs, most of the ports undertook dredging activities. In fiscal year 1985 (October 1, 1984 - September 30, 1985) more than $33 million was spent for these activities.

SECTION 3

WEATHER, HYDROLOGY, AND OCEANOGRAPHY

In 1985 the major weather feature affecting the Gulf coast was the hurricane. Four hurricanes (Danny, Elena, Juan, and Kate) and a tropical storm (Bob) hit the area. Three hurricanes struck Louisiana, only the third time this century that as many as three hurricanes have struck one state in the Gulf region. It was the fourth year that no hurricane occurred over the Carribean. Figure 3-1 shows the tracks of these storms through the Gulf area.

Tropical storm Bob formed west of Fort Myers on July 22, moved east across Florida, up the eastern Florida and Georgia coasts and entered South Carolina. This storm caused little damage, but heavy rains and winds eroded beaches along the eastern U.S. coast.

Hurricane Danny developed out of an easterly wave in the Caribbean and became a tropical storm and hurricane on August 14 off the Louisiana coast. The center moved inland south of Lake Charles on the 16th. Though wind damage was light, flooding from heavy rains and the storm surge caused extensive damage. Crop damage was in the $10 to $13 million range, and property damage was $7 to $10 million.

Hurricane Elena developed in late August over Cuba and reached hurricane strength on August 29. After Elena entered the Gulf, the flow in which the storm was embedded weakened, and Elena, caught in a northeastward flow, made a loop off the Cedar Key, FL, area and headed west-northwestward. Elena moved inland in Mississippi with winds over 125 mph. Though the storm surge caused some damage, the wind caused more. Estimated crop and property damage exceeded $1 billion in Alabama, Mississippi, and Louisiana.

Hurricane Juan formed in the central Gulf of Mexico on October 25, became a tropical storm on the 26, and reached hurricane strength on the evening of the 27th. Juan's path was as erratic as Elena's, changing from a south-southeast course to a northerly course and on the 28th, 29th, and 30th making two cyclonic loops on the Louisiana coast. Juan moved eastward, went inland near the Alabama-Florida border, and then moved northward through Alabama. The storm meandered off the coast for almost 4 days and brought 5 to 8 foot storm surges, persistent southeast winds, and heavy rainfall that caused extensive damage. Total damage to property and crops was estimated at $1.5 billion, with 11 people killed and 1357 injured.

The last hurricane to affect the area was Kate, which formed near the Virgin Islands on November 13th and 14th. On the 15th Kate had reached tropical storm strength and by the 16th had

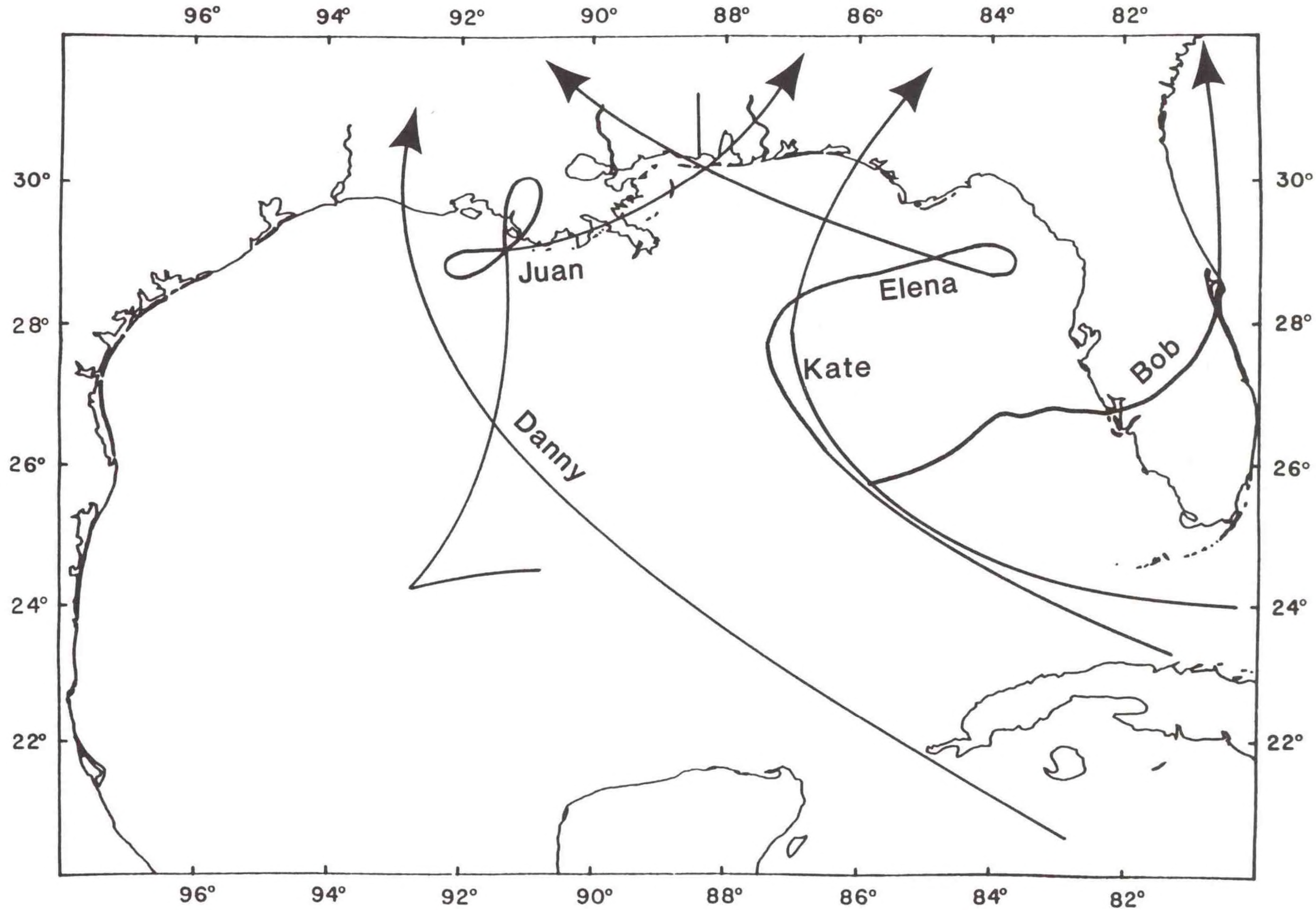

Figure 3-1.--Tracks of tropical cyclone that affected the Gulf Coast, 1985.

reached hurricane strength. Kate grazed the northwest tip of Cuba, swung to a northwesterly and northerly path, then curved and crossed the Florida coast between Apalachicola and Panama City. Kate caused wind damage in Key West, and the 8 to 10 feet storm tides damaged the coast of the panhandle of Florida. Total damage exceeded $50 million. Four people were killed, and 2 were injured in Florida.

3.1 Review of Weather Events

Though several low pressure systems tracked across the central Gulf area during January, continental high pressure systems dominated the weather in the Gulf. Cold Canadian air pushed southeastward in the third and fourth weeks. The cold air resulted in below-normal temperatures over the entire area. Gulf lows developed and initiated the precipitation that occurred in the South Texas and central Gulf areas. Heavy snow fell around the San Antonio, TX, area the second week.

Cold high pressure continued to dominate the circulation through the first half of February. A winter storm the beginning of the month dumped snow and frozen precipitation on Alabama, Mississippi, and Louisiana. A series of cold fronts brought precipitation into the Gulf region, particularly along a line from the central Texas coast northeastward through Louisiana and central Alabama.

The March circulation had a more southerly component to it, particularly the first and last 10-day periods. The circulation resulted in warmer-than-normal temperatures throughout the Gulf area. Cold fronts pushed through in the western and eastern Gulf, but stalled in the central area. This produced precipitation in the Texas and the central Gulf areas. Frontal activity did spawned tornadoes in central and southern Florida.

In April, circulation systems were shifting to more spring-like conditions with the main westerly upper-level winds shifting northward. One Gulf low developed out of an easterly wave and moved toward the east. Some cold fronts moved through the area early in the month, causing showers and generating thunderstorms and tornadoes in Alabama and Louisiana.

Though several fronts and two Gulf lows moved through the area in May, the main westerly mid-tropospheric flow was well north and kept the precipitation spotty. The fronts and squall lines that occurred initiated several thunderstorms and strong winds in Louisiana and Mississippi.

A persistent surface high-pressure pattern the first week of June brought a heat wave to the mid-south area. Early in the month, a stalled cold front in the San Antonio area dumped 7 to 14 inches of rain in two days causing flash flooding. Around mid-month a cold front brought needed rains to the central Gulf area. After that, the northward shift of the westerlies brought only spotty precipitation to the area.

Northwesterly mid-troposphere flow brought cool temperatures to the mid-Gulf area the first week of July. Fronts initiated damaging thunderstorms and flash floods during this week in Mississippi. Beneficial rains occurred the first week and after the middle of the month. Tropical storm Bob tracked across southern Florida at the end of the month and, although did little damage, dumped as much as 13 inches of rain in Naples, FL.

Hurricanes Danny in the middle of August and Elena at the end of the month were the prominent weather features in the Gulf. Though some mid-latitude fronts came as far south as the Gulf and set off showers, the hurricanes dominated the weather.

In September more fall-like circulation developed. Frontal passages with incursions of cooler air from the north are typical of the fall circulation. Hurricane Elena came ashore in early September with strong winds and storm surge that caused major damage. A small upper-level circulation pattern contributed to excessive rains over peninsular Florida after mid-month.

For three-fourths of October, circulation was quite fall-like with cold front passages bringing cooler air and subsequent warmer southerly flow, as the high pressure patterns moved eastward. However, with the development of hurricane Juan and the associated winds and rain, the monthly pattern changed. Juan dominated the Gulf circulation from the 25th through the end of the month. This storm contributed to the above-normal temperatures and the excessive precipitation that occurred this month.

In November an upper-level trough poured cold air into the northwest United States for a large part of the month. This circulation allowed warm southerly air to continue to flow into the Gulf area for most of the month giving warm and generally dry conditions. The final hurricane of the season, Kate, first affected the Florida Keys and then hit the panhandle of Florida the latter part of the month. Fronts that moved slowly through central Texas led to heavy rains (up to 21 inches) and flooding.

In December, the upper-level trough moved over the Mississippi valley, pushing cold continental air further southeastward than in November, bringing cold weather to the Gulf area. The cold fronts and associated squall lines touched off thunderstorms in the west and central Gulf and tornadoes in Texas. These fronts also brought freezing temperatures to the Gulf area on a regular basis.

3.2 Precipitation and Air Temperature

For the year as a whole the precipitation pattern showed slightly below-normal amounts in peninsular Florida and normal to above-normal quantities to the rest of the Gulf area at the selected National Weather Service stations shown in Figure 3-2 and listed in Tables 3-1 and 3-2. Florida's temperatures were slightly above normal for the year. Temperatures at the rest of the stations around the Gulf were near normal.

In January, precipitation was below normal in peninsular Florida, above normal along the southern Texas coast, and close to normal in the central Gulf. Temperatures were below normal over the entire south central and southeastern United States. This temperature pattern was in sharp contrast to the temperature regime in December 1984, which had way above-normal temperatures over the same area.

February precipitation was above normal from part of the Florida panhandle to southern Texas, except for Brownsville, which was dry. Peninsular Florida remained dry for the sixth straight month, however. Temperatures were above normal in Florida, but below normal west of there for the second consecutive month.

Precipitation in March was above normal from Mississippi westward through Texas, except for Brownsville. Coastal areas east of Mississippi had below-normal rainfall, except for the areas around Orlando and from the Everglades south, which had normal or above-normal precipitation. Temperature were above normal over the whole area.

April was very dry (about 40 percent of normal) from central peninsular Florida through parts of Texas. Rainfall amounts were above normal in southern Florida and southern Texas, however. Temperatures were slightly above normal in the western half of the Gulf and ranged from slightly above normal to slightly below normal in the eastern half.

Precipitation in May was below normal over most of the area, with only southern Florida, the Alabama-Florida border, the Louisiana-Texas border, and southern Texas receiving above-normal rainfall. Thus for spring (March, April, May) only southern Texas and southern coastal Florida had normal precipitation, with areas inland in the central Gulf having less than 50 percent of normal. Temperatures in May continued warmer than normal in Texas and close to normal throughout the rest of the Gulf.

June's precipitation pattern was mixed with southern Texas and the area from central Louisiana to Tampa above normal. The rest of the area had below-normal precipitation. Temperatures were above normal in Florida and below normal westward.

Precipitation in July was even spottier than in June. Most of the selected stations had near-normal amounts, except for Texas, which had extremes from 50 percent of normal to almost three times normal. Temperatures were below normal over almost the entire area.

Table 3-1.--Normal monthly total precipitation (1951-1980) and percentage of normal, selected stations, Gulf of Mexico, 1985.

A. Normal monthly total precipitation (inches)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
Key West, Florida	1.74	1.92	1.31	1.49	3.22	5.04	3.68	4.80	6.50	4.76	3.23	1.73	39.42
Fort Myers, Florida	1.89	2.06	2.85	1.52	4.11	8.72	8.52	8.58	8.56	3.86	1.35	1.57	53.64
Tampa, Florida	2.17	3.04	3.46	1.82	3.38	5.29	7.35	7.64	6.23	2.34	1.87	2.14	46.73
Orlando, Florida	2.10	2.83	3.20	2.19	3.96	7.39	7.78	6.32	5.62	2.82	1.78	1.83	47.83
Tallahassee, Florida	4.66	5.00	5.60	4.13	5.16	6.55	8.75	7.30	6.45	3.10	3.31	4.58	64.59
Apalachicola, Florida	3.51	3.64	4.04	3.25	2.94	4.81	7.09	7.53	8.66	3.19	2.82	3.50	54.98
Pensacola, Florida	4.47	4.90	5.66	4.45	3.87	5.75	7.18	7.04	6.75	3.52	3.42	4.15	61.16
Mobile, Alabama	4.59	4.91	6.48	5.35	5.46	5.07	7.74	6.75	6.56	2.62	3.67	5.44	64.64
New Orleans, Louisiana	4.97	5.23	4.73	4.50	5.07	4.63	6.73	6.02	5.87	2.66	4.06	5.27	59.74
Baton Rouge, Louisiana	4.58	4.97	4.59	5.59	4.82	3.11	7.07	5.05	4.42	2.63	3.95	4.99	55.77
Lake Charles, Louisiana	4.25	3.88	3.05	4.06	5.14	4.19	5.55	5.39	5.21	3.47	3.76	5.08	53.03
Beaumont-Port Arthur, Texas	4.18	3.71	2.93	4.05	4.50	3.96	5.37	5.45	6.13	3.63	4.33	4.55	52.79
Galveston, Texas	2.96	2.34	2.10	2.62	3.30	3.48	3.77	4.40	5.82	2.60	3.23	3.62	40.24
Houston, Texas	3.21	3.25	2.68	4.24	4.69	4.06	3.33	3.66	4.93	3.67	3.38	3.66	44.77
Victoria, Texas	1.87	2.24	1.34	2.61	4.47	4.53	2.58	3.33	6.24	3.31	2.24	2.14	36.90
Corpus Christi, Texas	1.63	1.55	0.84	1.99	3.05	3.36	1.96	3.51	6.15	3.19	1.55	1.40	30.18
Brownsville, Texas	1.25	1.55	0.50	1.57	2.15	2.70	1.51	2.83	5.24	3.54	1.44	1.16	25.44

Table 3-1 (Continued).--Normal monthly total precipitation (1951-1980) and percentage of normal, selected stations, Gulf of Mexico, 1985.

B. Percentage of normal precipitation, 1985.

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
Key West, Florida	18	15	164	711	136	11	99	123	99	64	81	132	107
Fort Myers, Florida	36	21	72	97	29	43	102	91	137	176	163	42	89
Tampa, Florida	95	68	52	53	7	122	88	113	145	204	53	53	95
Orlando, Florida	43	45	143	77	76	61	94	184	97	90	46	189	99
Tallahassee, Florida	66	30	82	24	50	115	109	139	35	243	183	157	97
Apalachicola, Florida	159	49	63	26	93	81	108	215	62	352	230	121	125
Pensacola, Florida	102	104	73	47	137	125	56	102	83	422	104	141	113
Mobile, Alabama	110	130	85	23	106	78	107	64	157	504	44	80	108
New Orleans, Louisiana	97	177	149	47	23	98	103	106	98	496	24	91	112
Baton Rouge, Louisiana	100	120	90	29	56	133	125	137	143	383	11	94	108
Lake Charles, Louisiana	80	175	117	31	73	35	76	126	40	367	80	74	100
Beaumont-Port Arthur, Texas	82	185	162	28	114	80	129	206	121	320	89	60	129
Galveston, Texas	97	232	268	46	61	98	188	56	50	131	69	71	102
Houston, Texas	65	166	169	102	33	130	148	31	95	178	143	105	110
Victoria, Texas	180	88	411	328	23	154	49	56	53	61	78	111	108
Corpus Christi, Texas	164	185	217	178	94	119	53	82	136	107	105	115	122
Brownsville, Texas	119	35	80	122	196	240	277	74	115	114	71	36	129

Table 3-2.--Normal monthly mean air temperature (1951-1980) and departure from normal, selected stations, Gulf of Mexico, 1985.

A. Normal monthly air temperature (Degrees F)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
						Month							
Key West, Florida	68.7	70.1	74.1	77.7	80.6	82.9	84.5	84.3	82.6	80.1	75.5	71.0	77.7
Fort Myers, Florida	63.4	64.1	68.8	73.1	77.9	81.1	82.6	82.8	81.7	76.5	69.8	64.7	73.9
Tampa, Florida	59.8	60.8	66.2	71.6	77.1	80.9	82.2	82.2	80.9	74.5	66.7	61.3	72.0
Orlando, Florida	60.5	61.5	66.8	72.0	77.3	80.9	82.4	82.5	81.1	74.9	67.5	62.0	72.4
Tallahassee, Florida	51.6	53.6	60.2	67.1	74.0	79.5	81.2	81.1	78.3	68.4	58.8	53.0	67.2
Apalachicola, Florida	52.8	54.7	60.7	67.9	74.5	79.8	81.5	81.4	78.9	70.2	61.0	55.0	68.2
Pensacola, Florida	51.7	54.2	60.4	68.0	75.0	80.6	82.3	81.8	78.7	69.4	59.7	53.8	68.0
Mobile, Alabama	50.8	53.6	60.1	68.0	74.9	80.5	82.2	81.8	78.2	68.5	58.6	53.1	67.5
New Orleans, Louisiana	52.4	54.7	61.4	68.7	74.9	80.3	82.1	81.7	78.5	69.2	60.0	54.6	68.2
Baton Rouge, Louisiana	50.8	53.6	60.5	68.4	74.8	80.3	82.1	81.4	77.9	68.2	58.7	53.1	67.5
Lake Charles, Louisiana	51.5	54.3	60.7	68.4	74.9	80.4	82.3	81.8	78.2	69.3	59.7	53.9	68.0
Beaumont-Port Arthur, Texas	51.9	54.9	61.4	69.0	75.6	81.2	83.1	82.8	79.2	70.2	60.6	54.7	68.7
Galveston, Texas	53.6	55.6	61.4	69.1	75.7	81.2	83.2	83.2	80.0	72.7	63.0	56.8	69.6
Houston, Texas	51.4	54.5	61.0	68.7	74.9	80.6	83.1	82.6	78.4	69.7	60.1	54.0	68.3
Victoria, Texas	53.4	56.6	63.3	70.9	76.7	82.0	84.5	84.2	80.1	71.9	62.3	56.1	70.1
Corpus Christi, Texas	56.3	59.3	65.9	73.0	78.1	82.7	84.9	85.0	81.5	74.0	65.0	59.1	72.1
Brownsville, Texas	60.3	62.8	68.6	74.9	79.2	82.6	84.1	84.1	81.4	75.3	67.7	62.3	73.6

Table 3-2 (Continued).--Normal monthly mean air temperature (1951-1980) and departure from normal, selected stations, Gulf of Mexico, 1985.

B. Departure from normal, 1985 (Degrees F)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
						Month							
Key West, Florida	-1.7	+1.7	+1.2	-1.4	+0.8	+2.2	-1.2	-0.3	-0.4	+2.0	+2.7	-2.0	+0.3
Fort Myers, Florida	-2.8	+2.9	+2.8	+0.8	+2.1	+2.6	-0.4	+1.7	+1.4	+5.3	+5.8	-1.2	+1.8
Tampa, Florida	-3.9	+2.8	+3.2	+0.9	+2.7	+2.8	+0.2	+0.9	-0.4	+4.7	+6.9	-2.3	+1.5
Orlando, Florida	-5.8	-0.7	+1.6	-1.3	-0.1	+1.5	-0.3	-0.2	-1.3	+4.5	+5.5	-3.2	+0.1
Tallahassee, Florida	-5.1	+2.6	+4.3	-0.7	+0.8	+1.0	-0.7	-0.3	-0.8	+6.0	+7.9	-4.7	+0.9
Apalachicola, Florida	-4.7	+0.4	+3.3	-1.7	0.0	+0.1	-1.1	-1.0	-1.4	+5.2	+7.5	-2.5	+0.3
Pensacola, Florida	-4.8	-0.1	+4.9	+0.8	+0.5	+1.1	-1.2	+0.1	-0.6	+4.6	+8.1	-3.0	+0.9
Mobile, Alabama	-7.3	-2.9	+4.4	-0.3	-1.2	-0.6	-2.5	-0.8	-2.2	+2.9	+7.5	-4.3	-0.6
New Orleans, Louisiana	-7.2	-2.4	+3.9	+0.3	-0.2	-1.0	-1.9	-0.1	-1.5	+3.4	+7.3	-3.6	-0.3
Baton Rouge, Louisiana	-7.0	-3.2	+4.4	+0.3	-0.8	-0.1	-1.4	+0.6	-1.4	+3.9	+7.6	-4.5	-0.1
Lake Charles, Louisiana	-6.4	-4.4	+4.0	+1.5	+0.5	+0.7	-0.4	+1.4	-0.7	+2.6	+6.5	-4.5	+0.1
Beaumont-Port Arthur, Texas	-3.8	-1.8	+5.6	+3.1	+0.6	-0.2	-1.4	+0.5	-0.5	+2.2	+6.0	-3.9	+0.5
Galveston, Texas	-5.5	-5.6	+1.8	+1.2	+0.6	-1.3	-1.5	+0.5	-0.1	+0.3	+5.1	-2.5	-0.6
Houston, Texas	-5.7	-4.9	+3.7	+1.3	+0.7	+0.4	-1.5	+1.6	+1.4	+2.8	+6.9	-3.0	+0.3
Victoria, Texas	-6.1	-4.0	+3.4	+0.5	+1.8	0.0	-1.0	+2.0	+1.0	+1.9	+5.1	-3.4	+0.1
Corpus Christi, Texas	-7.1	-5.2	+1.7	-0.7	-0.5	-2.5	-2.9	-0.9	-0.8	+1.2	+4.0	-3.6	-1.4
Brownsville, Texas	-5.9	-3.6	+2.8	+1.0	+1.4	-0.1	-1.2	+0.8	+0.7	+1.4	+5.3	-1.9	+0.1

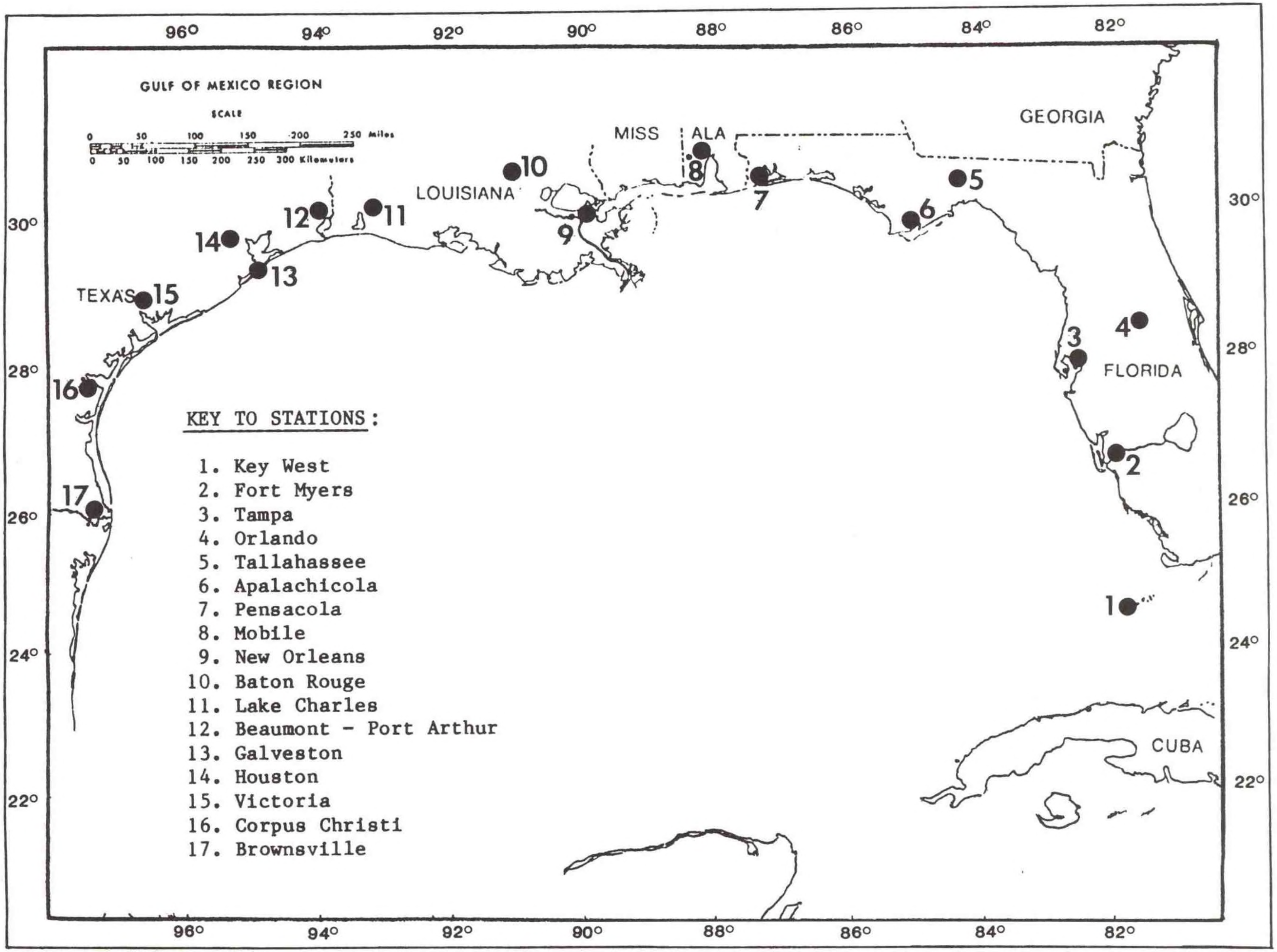

Figure 3-2.--Selected National Weather Service meteorological stations, Gulf of Mexico coastal region (Modified U.S. Department of Interior map).

August precipitation was above normal along the path of hurricane Danny through Louisiana, Mississippi, and into central Alabama. Precipitation was also high from central Florida through the panhandle. Rainfall in southeastern Texas was below normal. For the summer season (June, July, August) precipitation was above normal from central peninsular Florida through the eastern Texas coast. Temperatures were near normal over the eastern Gulf and slightly above normal in Louisiana and Texas.

In September precipitation was above normal along hurricane Elena's path in southern Texas and in southern coastal Florida. Precipitation was below normal in northern Florida and the panhandle and along the western Louisiana, northeastern Texas coast. Temperatures were below normal over most of the coastal areas, except for southern Texas, which had slightly above-normal temperatures.

October's precipitation was greatly affected by hurricane Elena which gave above-normal values from southern Florida to eastern Texas. The average for the stations from Fort Myers, FL, to Port Arthur, TX, was more than three times normal. With the hurricane's tropical influence, temperatures were above normal over the entire Gulf area.

November was drier than October over parts of the northern Texas coast, Louisiana, Mississippi, and northern peninsular Florida. However, the panhandle of Florida had above-normal precipitation from hurricane Kate. The fall (September, October, November) precipitation was above normal from southern Florida to the eastern Texas coast, with only extreme southern Florida and the central Texas coast below normal. Above-normal temperatures in November over the entire area contributed to above-normal values for the fall season.

Precipitation in December was below normal in southern Florida, from Alabama to the central Texas coast, and in southern Texas. Only a small area along the central Texas coast and around the Florida panhandle had above-normal values. Temperatures for the entire area plunged below normal, a sharp contrast to November's above-normal values.

3.3 Streamflow and Water Quality

Estuaries along the Gulf of Mexico coast support major fisheries and recreational industries. The quality of the estuarine waters influences the well-being of these industries. Water quality in the estuary is a function of freshwater flow, the amount of nutrients brought with this flow, and the degree of mixing in the estuary.

Nutrient loads to the coast are increased by point discharges and non-point sources in the drainage basin and coastal counties. Point sources include sewage treatment plants and industrial plants. Non-point sources of nutrients are urban and agricultural runoff and indirect industrial dischargers. The quantity of such discharges follows patterns of population and development. Estuaries such as Tampa Bay on the Florida coast, Mobile Bay and Lake Pontchartrain on the northern coast, and Galveston Bay on the Texas coast receive large loads of nutrients from local sources and have experienced water quality problems attributed to such sources.

Dissolved oxygen levels in Gulf coast estuaries are usually not problematic. Most estuaries are shallow and experience sufficient mixing from winds and tides to keep the water column well oxygenated. Recently, however, hypoxic conditions (oxygen concentrations less than 4.0 milligrams per liter) have been noted in some estuaries and along parts of the inner continental shelf in Louisiana. Oxygen depletion usually occurs in the summer, when water temperatures and benthic metabolic rates are high, and winds are weak. Lack of mixing leads to thermohaline stratification, which, when combined with a source of oxidizable matter such as sewage effluent, can result in hypoxia.

Concentrations of suspended sediment and organic material influence water turbidity and the degree of light penetration, which in turn influence primary productivity. High concentrations of suspended sediments may adversely affect benthic organisms such as oysters by burying them.

Nutrient-rich waters support high levels of primary productivity resulting in good harvests of fish and shellfish. However, if nutrient levels become too high, the waters become eutrophic, causing algal blooms followed by possible fish kills. Eutrophic waters are unpleasant and may be dangerous to those who pursue water activities. Recent studies indicate low dissolved oxygen levels are occurring with increasing frequency along the coast and may affect the abundance and distribution of fish and benthic communities.

For purposes of assessing Gulf coast estuaries, the coast may be divided into three geographical regions: the Florida coast, the northern coast including Alabama, Mississippi, and Louisiana, and the Texas coast. Nutrient and sediment loadings from freshwater sources are greatest along the northern Gulf coast due to the large flow and drainage basin of the Mississippi/Atchafalaya river system. The rivers carrying the next largest loads, the Mobile and the Pearl, also empty into the northern Gulf coast. Moving east or west along the coastline mean freshwater inflow decreases.

3.3.1 Streamflow

Streamflow entering the Gulf of Mexico affects the Gulf region's fisheries, recreation, ecology, and water quality. The Gulf coast rivers drain more than 50 percent of the land area of the 48 contiguous United States. This large area, the subsequent large number of rivers draining the area, and the multiple upstream uses of the rivers' waters prevent analysis of total streamflow for the Gulf as a whole. Each river, however, is susceptible to the effects of both local and large-scale weather patterns. These patterns directly affect the rate and the quantity of streamflow entering individual estuaries of the Gulf of Mexico.

Many species of finfish and shellfish that are important commercially, recreationally, and ecologically use the estuaries for nursery and overwintering grounds. Streamflow affects the larvae and juveniles of these species in the estuaries by the manner in which it alters the temperature and salinity regimes that these species prefer.

Twelve major rivers and the locations of the corresponding streamflow monitoring stations are shown in Figure 3-3. Streamflow from the rivers from the Eastern Gulf westward through Louisiana normally have peak discharges in April and minimum flows in the fall months of September, October, or November. Streamflow for the Texas rivers, except for the Rio Grande, have maximum flows in May and minimum flows in August or October. The discharge pattern of the Rio Grande is different from the patterns of the other rivers with a minimum in March and a maximum in October. The rivers, with the exception of the Mississippi River, the Atchafalaya River, and the Brazos River, had below-normal flows for the year and showed cumulative streamflow deficits for 1985. However, streamflow among the stations was 114 percent of normal for the year, reflecting the overwhelming influence of the Mississippi and Atchafalaya Rivers on riverine discharge into the Gulf (Figure 3-4).

February streamflow was above normal for eight of the rivers cited and was greater than 95 percent of normal for 10 of the rivers. This was due in part to above-normal precipitation throughout the central Gulf area. Satellite imagery from the National Oceanic and Atmospheric Administration revealed January snowcover was the highest snowcover for that month in North America during the 19 year data record. Coupled with above-average rainfall, the melting snow contributed to record streamflow for the Mississippi River and near-record flow for the Atchafalaya River in March.

May through September streamflows were below normal and November and December flows were high, as 85 percent of the rivers had flow rates above normal.

Monthly data from the twelve selected stations are plotted in Figures 3-5a and 3-5b. Annual mean streamflow in 1984 and 1985 as percent of normal for each station is listed in Table 3-3.

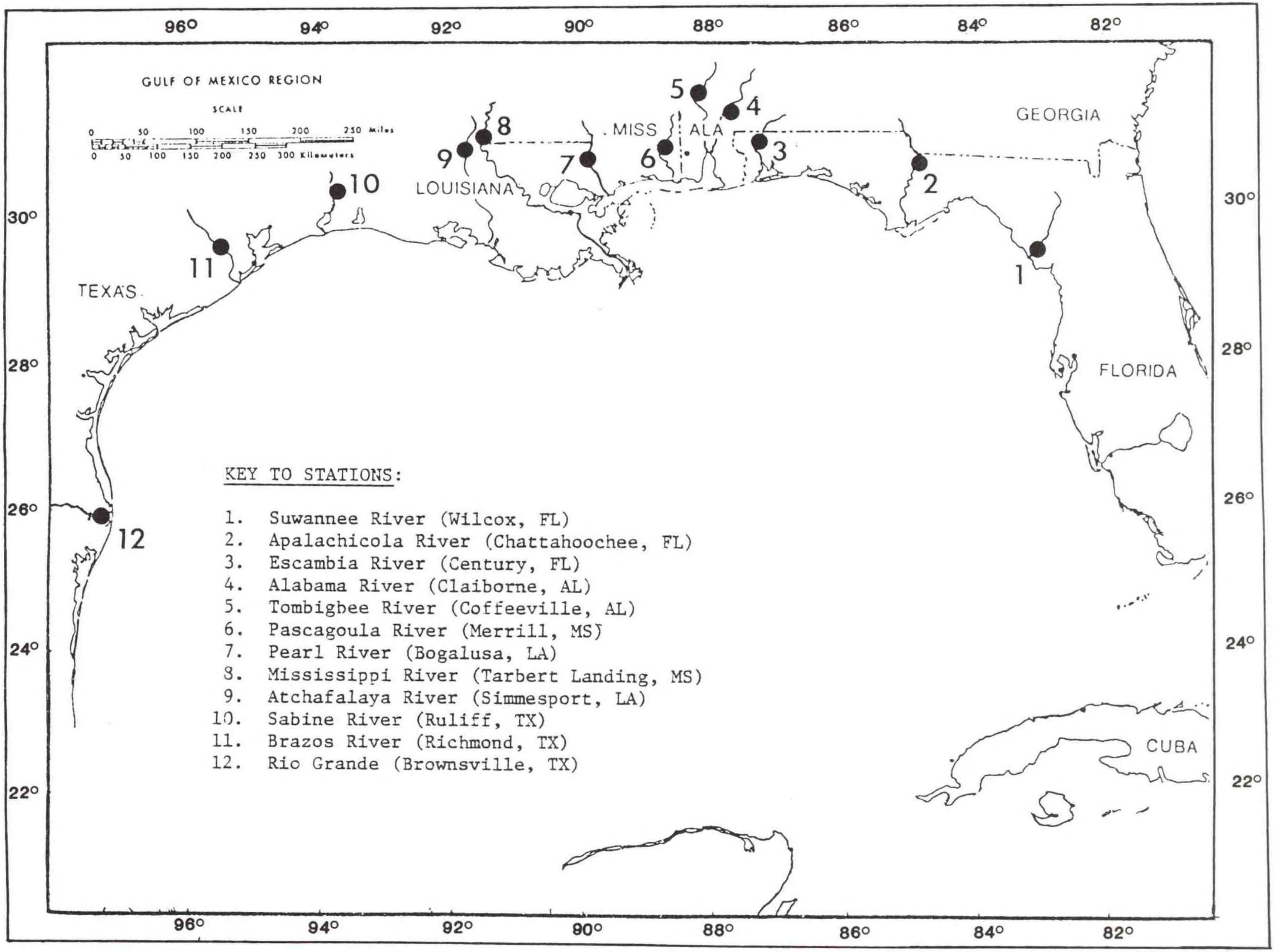

Figure 3-3.--Streamflow monitoring stations on major river systems entering the Gulf of Mexico (Modified U.S. Department of Interior map).

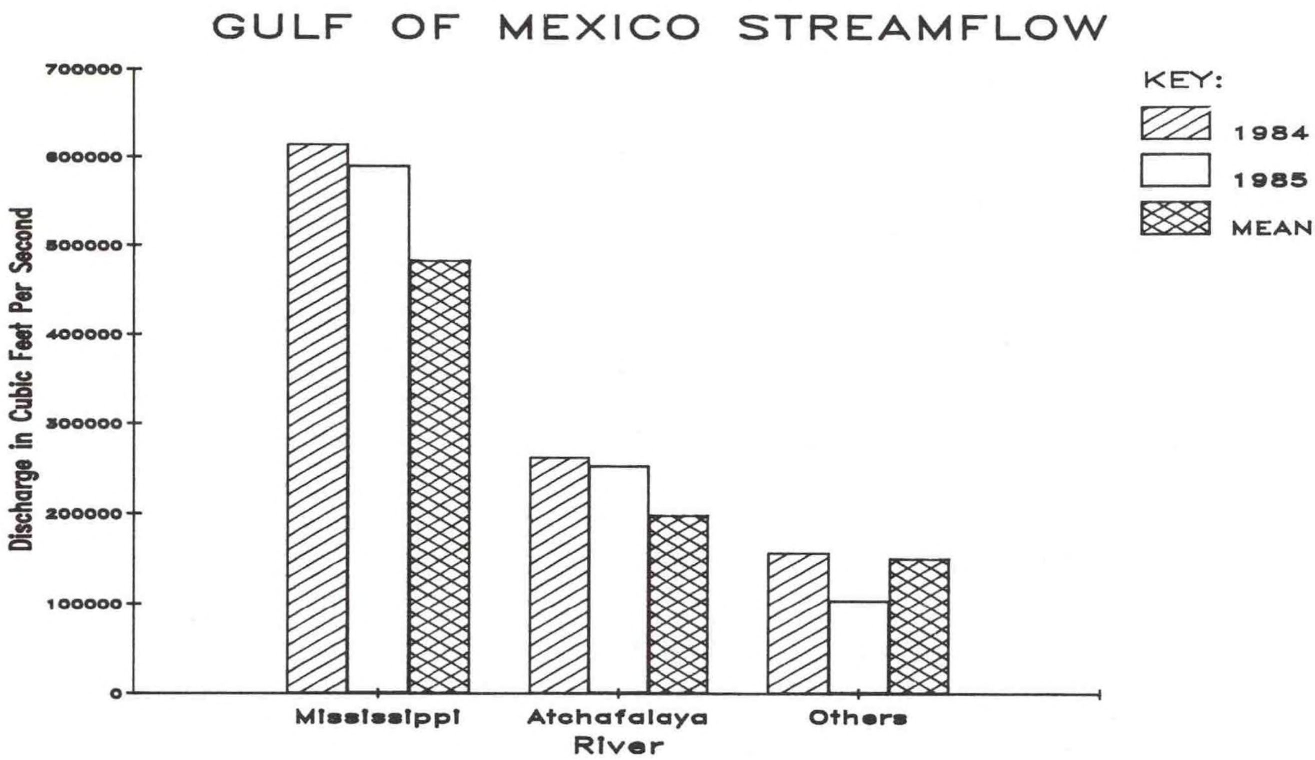

Figure 3-4.--Gulf of Mexico streamflow, 1984, 1985, and mean. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

Suwannee River

The Suwannee River flows into an area of the Gulf known as Suwannee Sound. The station located near Wilcox, FL, had below-normal streamflow for the first eight months of the year. Although flow rates were well above normal for the remainder of the year, the river had an annual cumulative deficit of 565 billion gallons.

Apalachicola River

The Apalachicola River flows into Apalachicola Bay. In 1985 the monitoring station at Chatahoochee, FL, measured below-normal streamflow for every month of 1985 except December. These flows accounted for a cumulative deficit for 1985 of 1,730 billion gallons.

Escambia River

Streamflow for the Escambia River, which flows into Pensacola Bay, is measured near Century, FL. Flows were above normal only for the months of February, July, November, and December. The river averaged 85 percent of normal flow for the year and ended with a cumulative deficit of 224 billion gallons.

Table 3-3.--Annual mean streamflow as percent of normal, selected stations, Gulf of Mexico, 1984-1985.

River	Normal Flow (CFS)	1984-1985 Flow (Percent of Normal) 1984	1985
Suwannee	10,207	165	76
Apalachicola	22,509	118	68
Escambia	6,159	101	85
Alabama	37,524	97	54
Tombigbee	31,373	94	66
Pascagoula	9,847	113	88
Pearl	9,764	112	86
Mississippi	484,500	129	122
Atchafalaya	199,500	132	127
Sabine	7,268	100	95
Brazos	6,680	49	104
Rio Grande	1,644	14	15

Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and International Boundary and Water Commission.

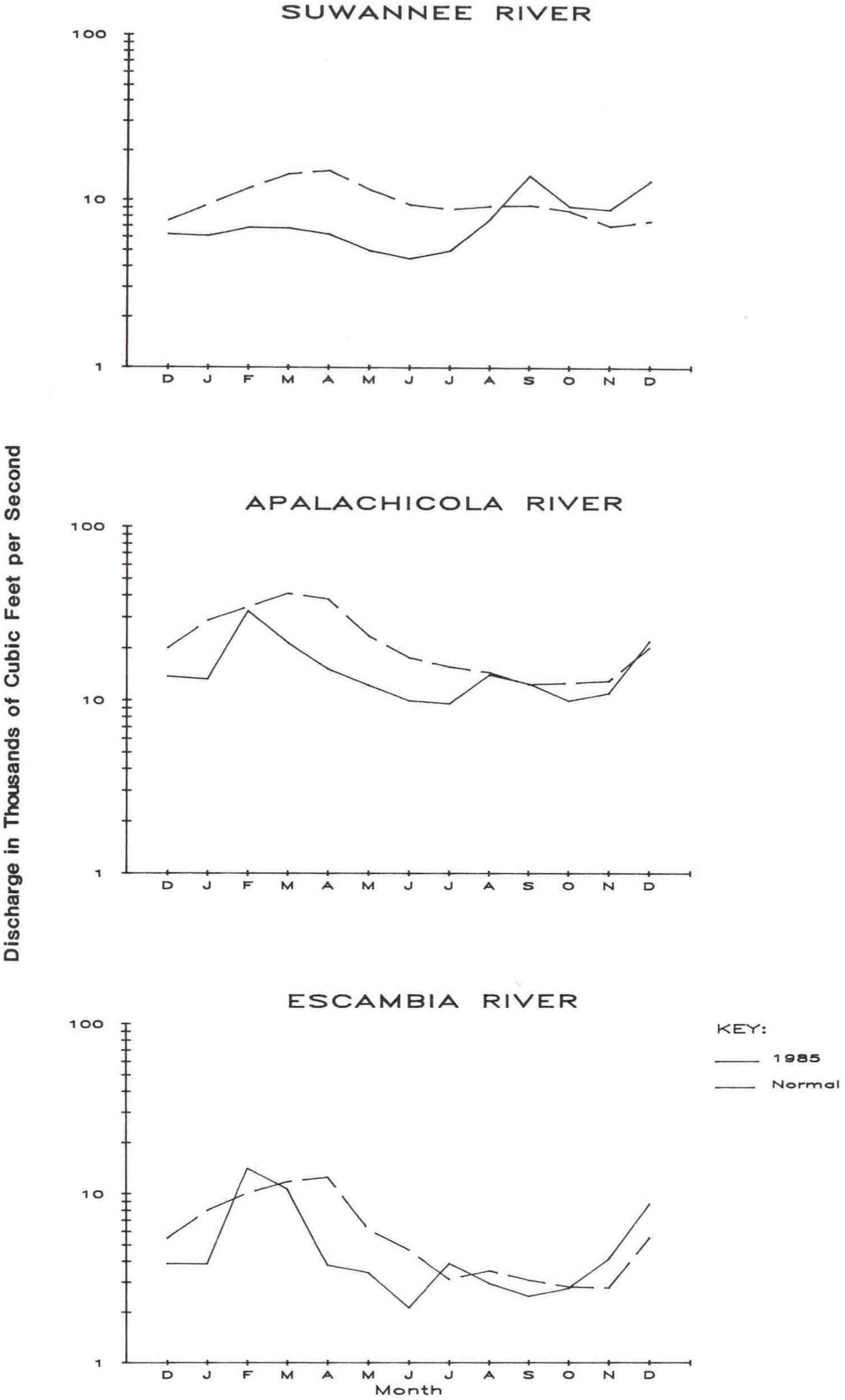

Figure 3-5a.--Monthly streamflow from major river systems entering the Gulf of Mexico during 1985 and average monthly streamflow. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

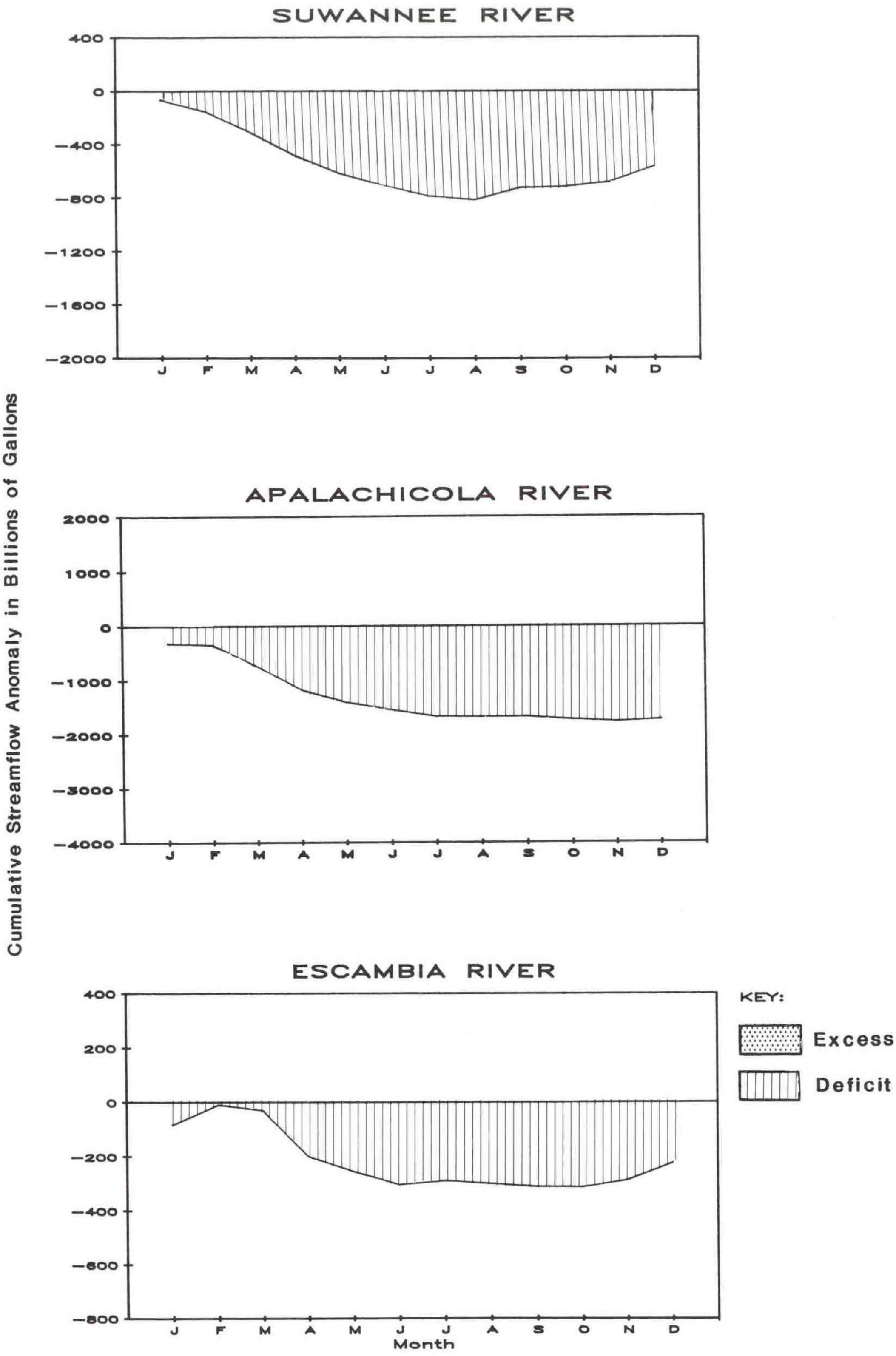

Figure 3-5b.--Cumulative monthly streamflow anomaly, major river systems entering the Gulf of Mexico, 1985. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

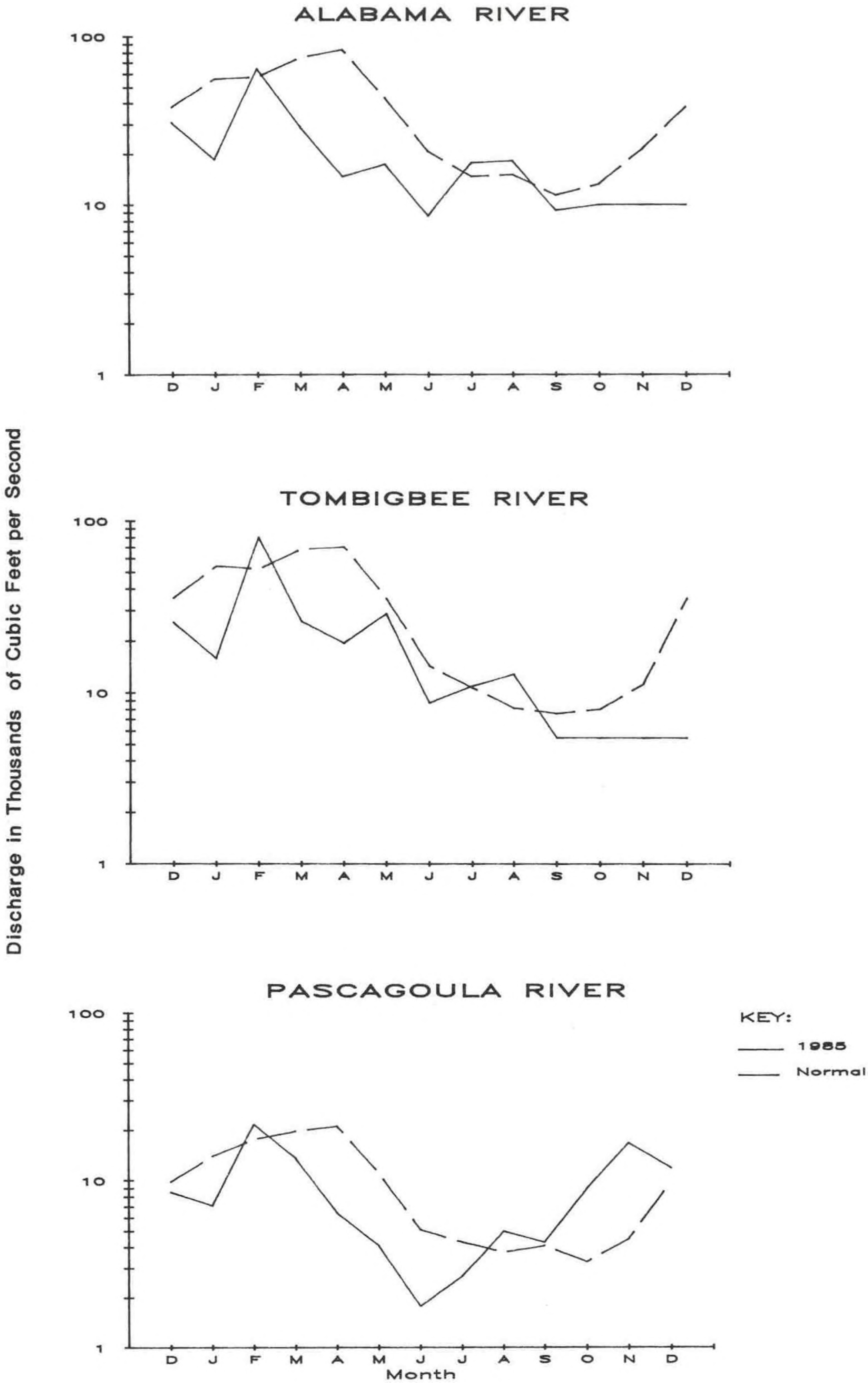

Figure 3-5a (continued).--Monthly streamflow from major river systems entering the Gulf of Mexico during 1985 and average monthly streamflow. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

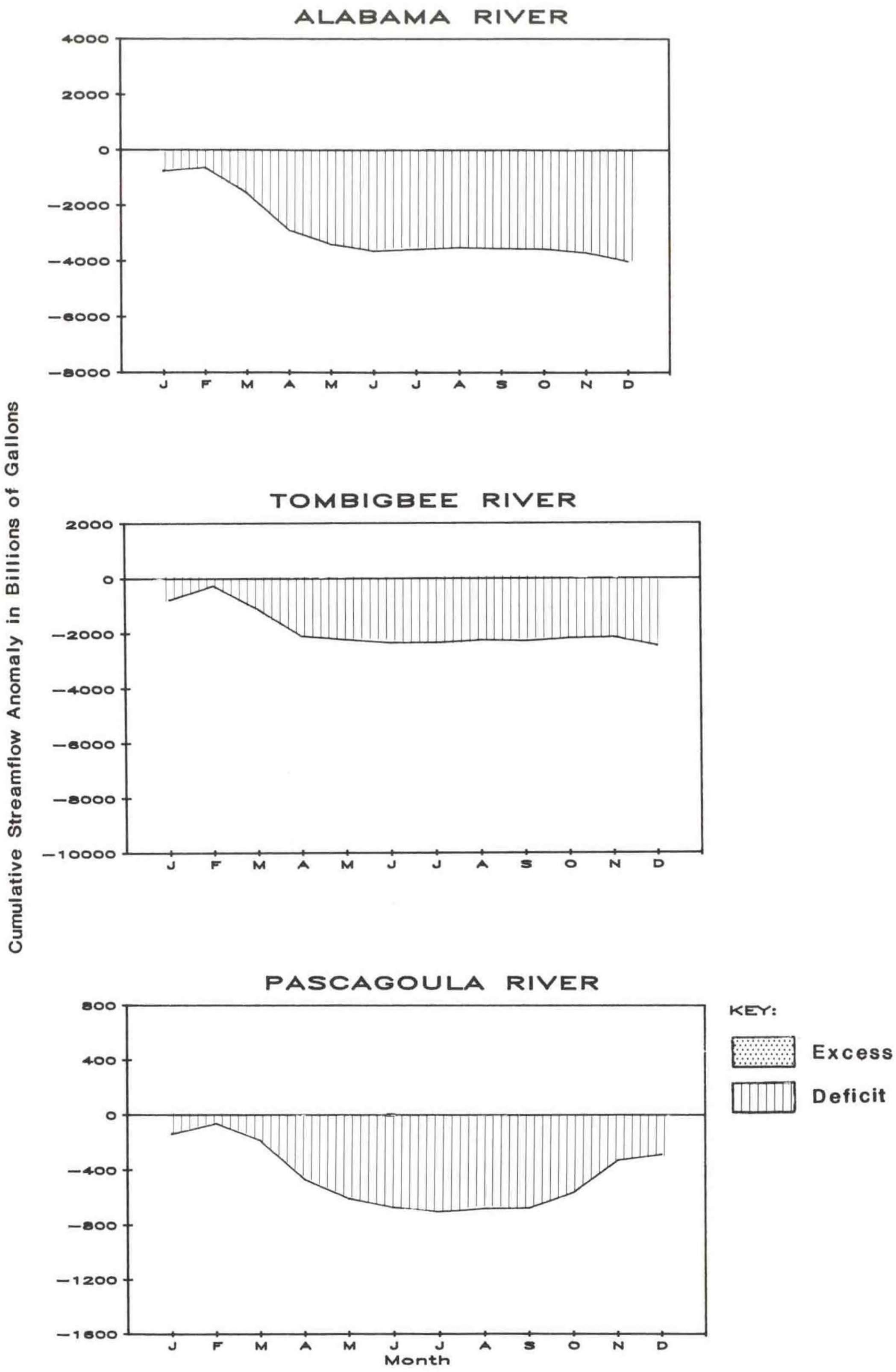

Figure 3-5b (continued).--Cumulative monthly streamflow anomaly, major river systems entering the Gulf of Mexico, 1985. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

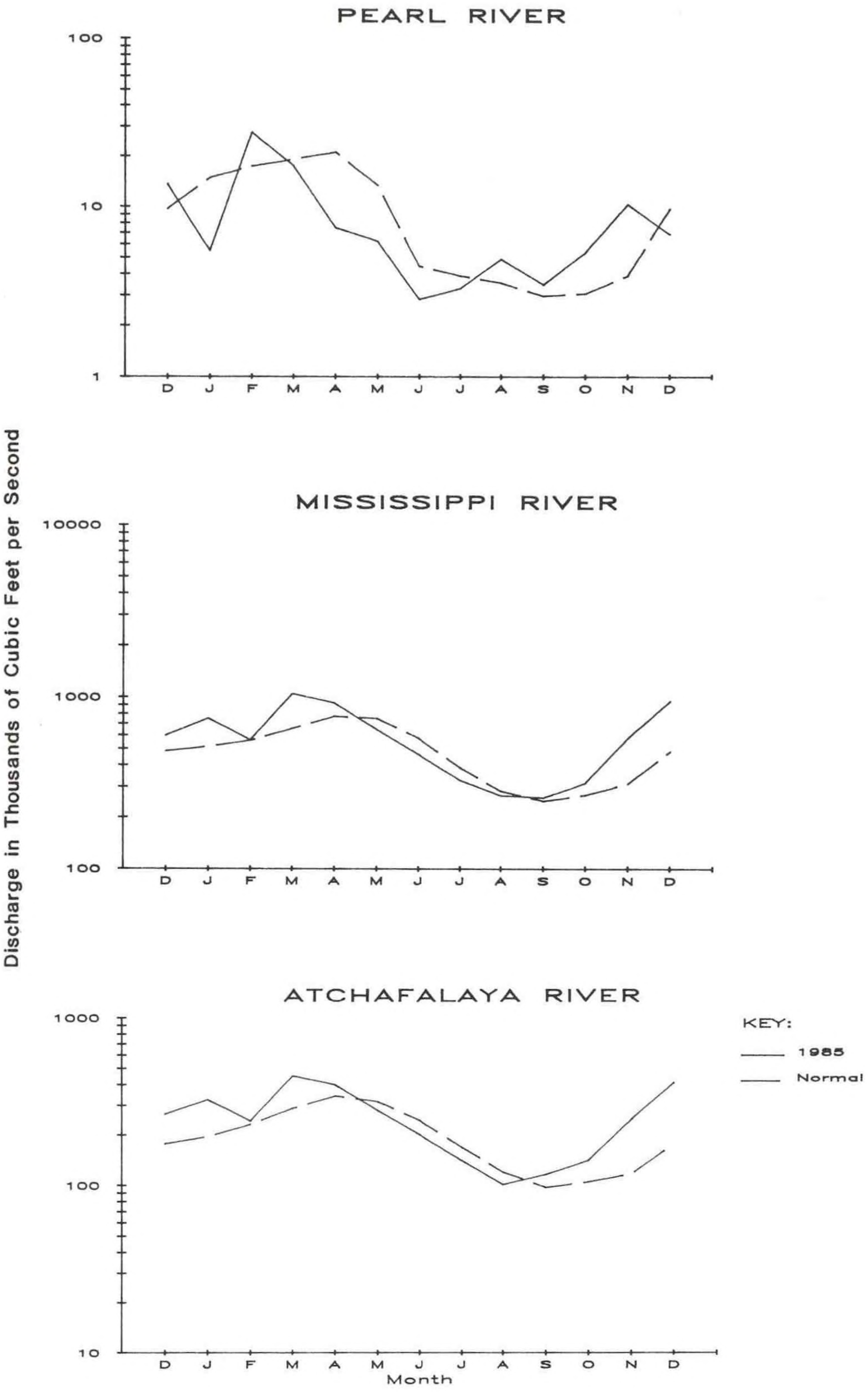

Figure 3-5a (continued).--Monthly streamflow from major river systems entering the Gulf of Mexico during 1985 and average monthly streamflow. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

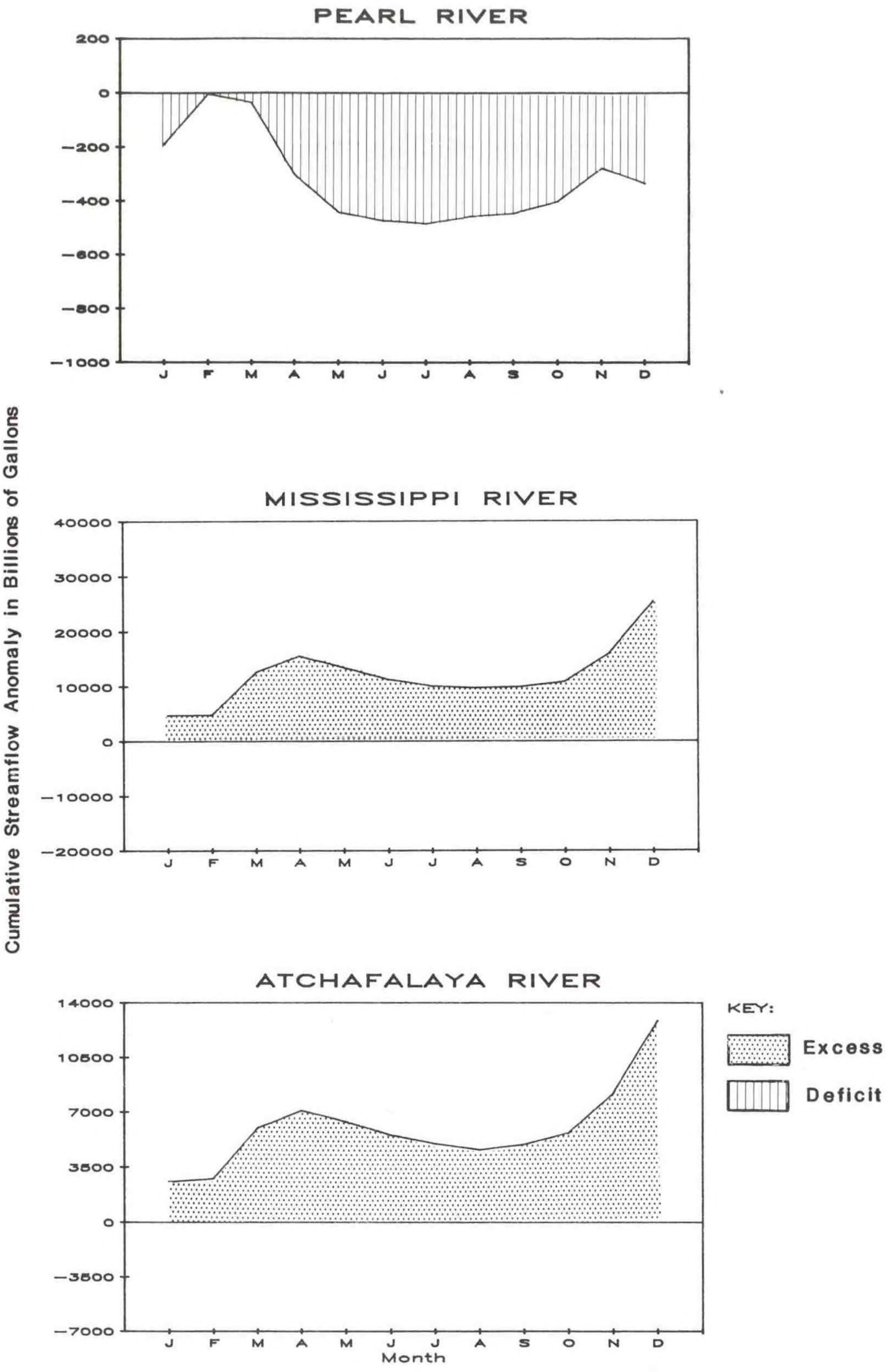

Figure 3-5b (continued).--Cumulative monthly streamflow anomaly, major river systems entering the Gulf of Mexico, 1985. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

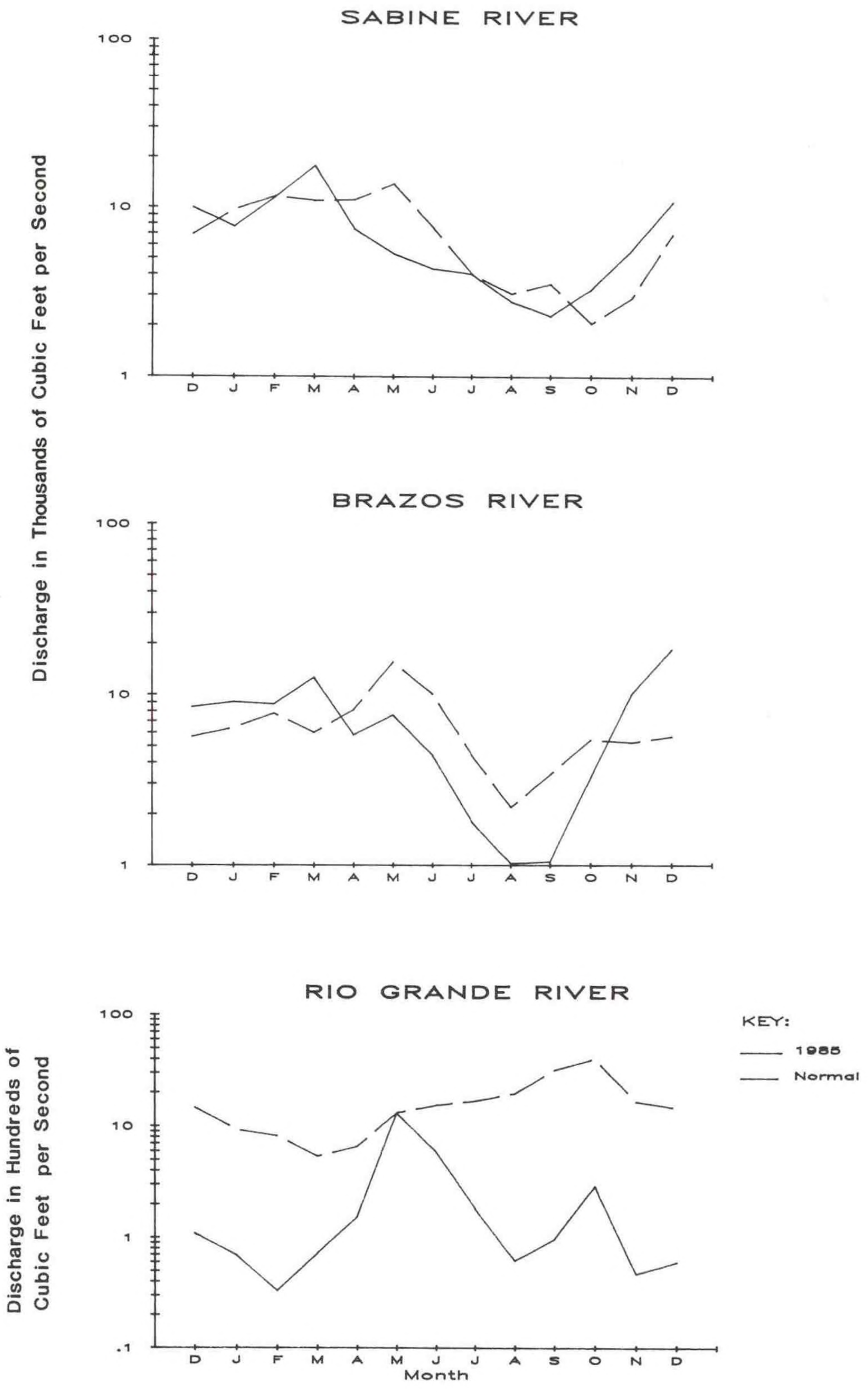

Figure 3-5a (continued).--Monthly streamflow from major river systems entering the Gulf of Mexico during 1985 and average monthly streamflow. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

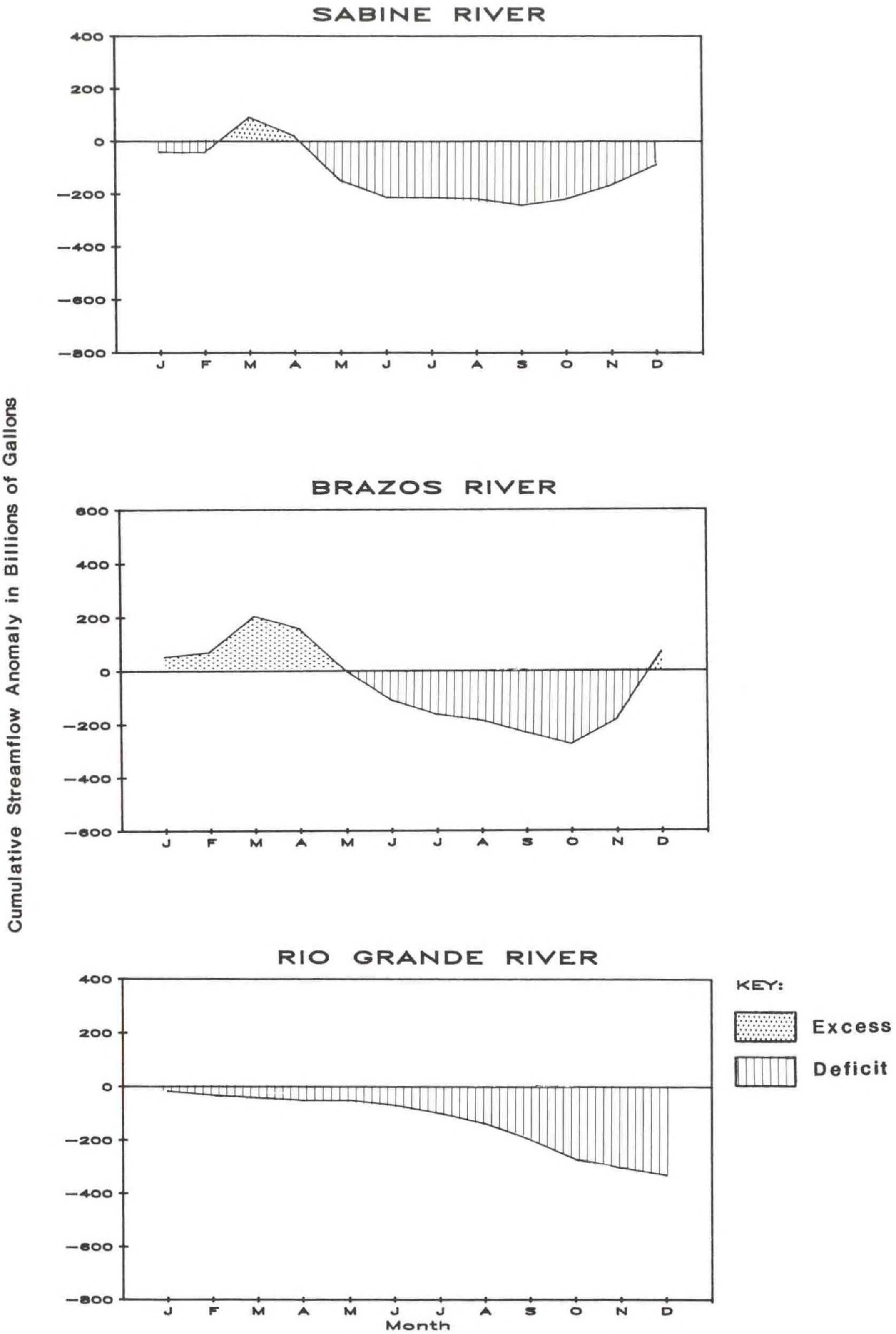

Figure 3-5b (continued).--Cumulative monthly streamflow anomaly, major river systems entering the Gulf of Mexico, 1985. Data from U.S. Geological Survey, U.S. Army Corps of Engineers, and the International Boundary and Water Commission.

Alabama River

The Alabama River flows into Mobile Bay, and streamflow is monitored at Claiborne Lock and Dam near Monroeville, AL. While the months of February, July, and August had above-normal streamflows, the rest of the months had flows that were below normal. The cumulative anomaly reached a deficit of 4,000 billion gallons by the end of December.

Tombigbee River

The Tombigbee River flows into Mobile Bay with streamflow monitored near Coffeeville, AL, at Coffeeville Lock and Dam. The streamflow pattern for this river was similar to that of the Alabama River with February, July, and August having above-normal flows and the remaining months having below-normal flows in 1985. The cumulative deficit was 2,450 billion gallons for 1985.

Pascagoula River

The Pascagoula River flows into an area of the Gulf known as the Mississippi Sound. Half of the months of the year had streamflows less than 70 percent of normal. These flows were so much below normal that even above-normal flows from August through the end of the year did not erase the cumulative deficit that amounted to 285 billion gallons for 1985.

Pearl River

The Pearl River, monitored near Bogalusa, LA, empties into Lake Borgne. The months of February and August through November had streamflows above normal. The annual flow, at 85 percent of normal, resulted in a cumulative deficit of 335 billion gallons.

Mississippi River

Streamflow for the Mississippi River, monitored at Tarbert Landing, MS, was above normal at the beginning and ending of the year with the months of May through August having below-normal flows. New maxima in March and December helped push the cumulative excess for the year to 25,300 billion gallons.

Atchafalaya River

The Atchafalaya River flows into Atchafalaya Bay and is monitored at Simmesport, LA. The flow pattern was the same for the Atchafalaya River as for the Mississippi River. March flow, which was the third highest on record, and new record high flow in December enabled the Atchafalaya to end 1985 with a cumulative excess of 12,900 billion gallons.

Sabine River

The Sabine River, monitored near Ruliff, TX, flows into Sabine Lake. Flow for the year was 75 percent of normal with the months of March and October through December the only months with above-normal streamflow. The above-normal flows at the end of the year brought the cumulative deficit from 240 billion gallons in September to 90 billion gallons at the end of 1985.

Brazos River

The Brazos River flows directly into the Gulf of Mexico. The station at Richmond, TX, had below-normal streamflow from April through October. Flow for the year was just above normal reflecting a cumulative excess for the year of 70 billion gallons.

Rio Grande River

The Rio Grande River flows directly into the Gulf of Mexico and is monitored at Brownsville, TX. Streamflow was below normal throughout the year with the highest flow, 1,310 cubic feet per second - 99 percent of normal - occurring in May. The cumulative streamflow anomaly was a deficit of 330 billion gallons for 1985.

3.3.2 Water Quality

Estuaries along the Gulf of Mexico coast support major fisheries and recreational industries. The quality of the estuarine waters, with respect to nutrients, dissolved oxygen and suspended constituents, influences the well-being of the fishing and recreational industries.

Water quality in the estuary is a function of freshwater inflow, the amount of materials carried into the estuary in river flow, and the type of mixing. Nutrient loads to the coast are increased by point discharges and non-point sources in the drainage basin and coastal counties. Point sources include waste water effluent from sewage treatment plants and industries. Non-point sources of nutrients are runoff from crop land and from urban areas. The quantity of such discharges follows patterns of population and development. Estuaries such as Tampa Bay on the Florida coast, Mobile Bay and Lake Pontchartrain on the northern coast, and Galveston Bay on the Texas coast (Figure 3-6) receive large loads of nutrients from local sources and have experienced water quality problems attributed to such sources.

Studies conducted in 1985 indicate dissolved oxygen levels in Gulf coast estuaries are becoming problematic. Most estuaries are shallow and should experience sufficient mixing from winds

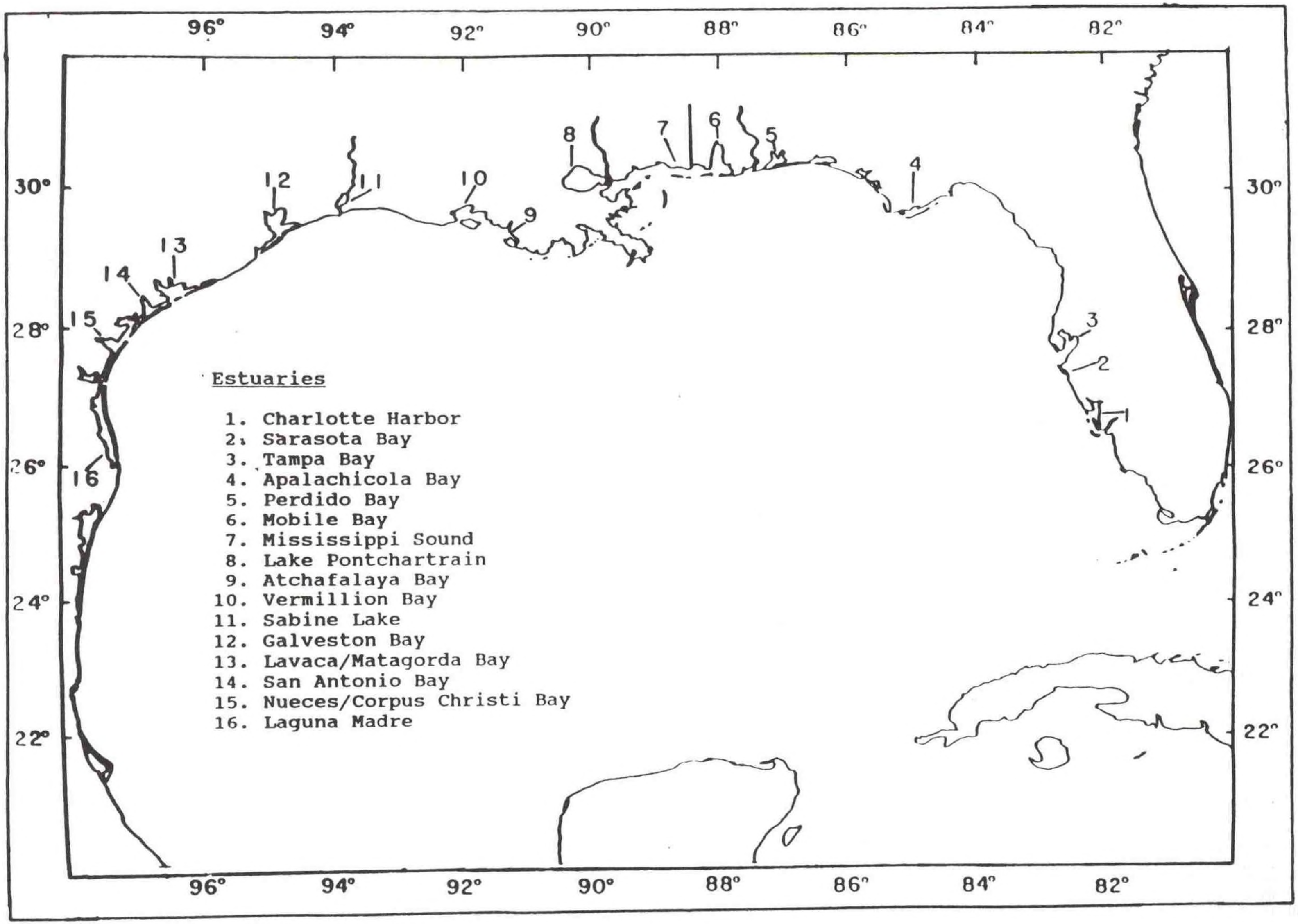

Figure 3-6.--Estuaries along the Gulf of Mexico coast.

and tides to keep the water column well oxygenated. In the recent past, however, repeated events of hypoxia (dissolved oxygen concentration less than 4.0 milligrams/liter) and anoxia have been noted in estuaries and along portions of the inner continental shelf. These estuaries include the following: Sarasota and Hillsborough Bays on the Florida coast; Perdido Bay, Mobile Bay, Mississippi Sound, Pascagoula Bay, Biloxi Bay, Lake Pontchartrain, Calcasieu Lake, and the Louisiana inner continental shelf on the northern Gulf coast; and Sabine Pass, Galveston/East/West Bays, Corpus Christi/Nueces Bays, and Lower Laguna Madre on the Texas coast. The low dissolved oxygen concentrations in these estuaries indicate that nutrient levels are probably higher than desirable. Recent evidence shows low dissolved oxygen may influence abundance and distribution of fish and benthic communities. This has been demonstrated by reductions in numbers of benthic macroinfaunal organisms and catches of demersal fish. Distribution and abundance of white and brown shrimp are also believed to be effected.

Oxygen depletion usually occurs in the summer when water temperatures and benthic metabolic rates are high and winds are weak, which reduces the degree of mixing. The lack of mixing leads to thermohaline stratification, which, when combined with a source of oxidizable organic matter such as sewage effluent, can result in hypoxia or anoxia. The most severe and repeated occurrences are in areas disturbed or altered by man, such as marinas ship channels. Mobile Bay is unique in that it has become hypoxic in the winter. Oxygen depletion along the Louisiana inner continental shelf is particularly severe to the west of Atchafalaya Bay. The reasons for depletion along the Louisiana inner continental shelf are not completely understood.

Concentrations of suspended sediment and organic material influence water turbidity and the degree of light penetration, which influence primary productivity. High concentrations of suspended sediments may adversely affect benthic organisms, such as oysters, by burying them. Oyster beds in Apalachicola Bay were closed in the latter half of 1985 due to high suspended solids concentrations resulting from hurricanes. Several Texas estuaries showed large decreases in suspended solids concentrations in 1985, the reasons for which are not known at this time.

Nutrient-rich waters support high levels of primary productivity resulting in good harvests of fish and shellfish. However, if nutrient levels become too high waters become eutrophic causing algal blooms, which can kill fish. Eutrophic waters are unpleasant and may be dangerous to those who pursue water activities due to high coliform counts often associated with nutrient enrichment. Parts of Tampa Bay are subject to algal blooms although no fish kills were reported in 1985.

For purposes of assessing Gulf coast estuaries, the coast may be divided into three geographic regions: the Florida coast, the northern coast and the Texas coast. Nutrient and sediment loadings from freshwater sources are greatest in the northern Gulf coast due to the flow and drainage basin of the Mississippi/Atchafalaya river system. The rivers carrying the next largest loads, the Mobile and the Pearl, also empty into the northern Gulf coast. Moving east or west along the coastline mean freshwater inflow decreases.

Water quality data were obtained from Texas , Florida, and Louisiana. Texas data consist of average concentrations for 1985 and for the period 1970-1984. Florida data consist of average concentrations for 1985, for the period 1970-1984, and, for Tampa Bay only, the period 1970-1984. Data for 1985 from Louisiana were collected along the inner continental shelf at stations located 2-15 kilometers offshore.

Florida and Texas data were collected by state agencies for the Environmental Protection Agency (EPA) to comply with federal water quality standards. The states must use analytical techniques established by the federal government so their data are comparable. Data collection in Louisiana also followed federal standards.

Florida Gulf Coast

Data from Florida estuaries were provided by the Florida Department of Environmental Regulations (DER). Each estuary is divided into segments by DER, and stations are monitored within each segment depending on its size. Data presented here are the 1985 concentration averages and/or 1970-1984 long-term averages for selected portions of Apalachicola Bay, Tampa Bay, and Charlotte Harbor. Parameters reviewed are secchi depth (SD), chlorophyll-a (Chl-a), total nitrogen (TN), total phosphorous (TP), and trophic state index (TSI).

The trophic state index allows comparison of overall water quality among Florida estuaries. The TSI must incorporate TN and TP but takes into account SD and Chl-a, when those measurements are available. The following scale, developed by DER and based on EPA water quality standards, provides an effective method for classifying water quality in Florida estuaries: 0-49 is good, 50-59 is fair, and 60-100 is poor.

<u>Charlotte Harbor</u>

Charlotte Harbor is an area of critical concern to Florida, because the present rapid population growth could cause water quality, which is currently good, to diminish, increasing the potential for damage. The surface area of the estuary is 311 square miles. Primary sources of freshwater inflow and average annual flow rates are the Peace River, 1200 cubic feet per second (cfs); Myakka River, 1060 cfs; and Caloosahatchee River, 1300 cfs.

While water quality is considered good, nutrient levels, especially phosphorous, are high, and secchi readings are somewhat lower than desirable. Phosphate mining activities in the upper Peace River basin elevate naturally high phosphorous levels in the vicinity of the bay. The phosphorous levels are high because the rivers cut through a layer of phosphatic rock on their courses to the coast.

Water quality is generally better in the northern half of the bay than the southern half (Table 3-4). Based on the TSI, both halves showed water quality improvement in 1985 over the long-term average. Notable improvement in water clarity occurred in the southern half, where secchi depth increased by 0.30 meters in 1985.

Tampa Bay

Tampa Bay is one of the largest Gulf Coast estuaries, with a surface area of about 346 square miles. The major rivers flowing into the bay and their average annual flow rates are the Hillsborough, 400 cfs; Alafia, 330 cfs; and the Little Manatee, 170 cfs. Due to small freshwater inputs and the basin's geomorphology, the flushing rate of the bay is naturally slow.

Water quality in Tampa Bay has declined over the past few decades due to increased development along its shores. Urban development has resulted in several changes to the environment: loss of upland vegetative ground cover and subsequent erosion and storm water runoff into the Bay, loss of wetlands and submerged aquatic vegetation due to dredge and fill activities, alterations to the bay associated with increased shipping, and increased nutrient loading from point sources. Water quality problems are aggravated by the bay's slow flushing rate.

Since no 1985 data were available from Tampa Bay, only historic averages from 1970-1984 are shown (Table 3-4). The long-term averages reflect the spatial trends described below. There is no information indicating these trends changed much in 1985.

The bay may be divided into three sections based on geomorphology and differences in water quality: Hillsborough Bay, Old Tampa Bay, and Lower Tampa Bay. Hillsborough Bay is in the eastern lobe of the estuarine system and is fed by the Hillsborough and Alafia Rivers. This bay has the worst water quality of the three sub-bays (Table 3-4). The bay receives large quantities of phosphorous originating from phosphorous mining operations in the Alafia's headwaters and from a phosphorous processing facility near the Alafia's mouth. Long-term average TP concentrations in Hillsborough Bay range from .56 mg/l to .58 mg/l (Table 3-4). This range is substantially higher than for either Apalachicola Bay or Charlotte Harbor and is the highest range in the Tampa Bay System. Hillsborough Bay also receives a considerable amount of urban runoff from the city of Tampa.

Table 3-4.-- Water quality in selected Florida estuaries.

Estuary/ Time	SD (meters)	Chl-a (ug/l)	TN (mg/l)	TP (mg/l)	TSI
<u>Charlotte</u>					
North					
1985	1.88	4.50	0.63	0.09	45
1970-1984	1.88	7.11	0.57	0.17	49
<u>Charlotte</u>					
South					
1985	1.12	*	0.90	0.09	55
1970-1984	0.82	*	0.78	0.09	58
<u>Tampa Bay</u> - <u>Sub-Bays</u>					
<u>Hillsborough</u>					
Best					
1970-1984	0.94	18.0	0.70	0.58	53
Worst					
1970-1984	0.70	26.0	1.05	0.58	59
<u>Old Tampa</u>					
Best					
1970-1984	1.32	11.0	0.67	0.51	51
Worst					
1970-1984	0.88	3.0	0.95	0.58	55
<u>Lower Tampa</u>					
Best					
1970-1984	2.21	9.0	0.45	0.33	38
Worst					
1970-1984	1.16	14.0	0.65	0.51	53
<u>Apalachicola</u>					
1985	0.64	7.50	0.57	0.03	51
1970-1984	0.74	9.27	0.63	0.04	52

* Data are unavailable.
Data from; Florida Department of Environmental Regulatiions.

Old Tampa Bay occupies the western lobe of the estuary. Water quality conditions in the area are between the levels of Hillsborough and Lower Tampa Bays. Old Tampa Bay receives discharges from many small sewage treatment plants, which do not meet required treatment levels due to rapid population growth, and algal blooms occur frquently in the northern extremities of the bay. Data are not sufficient to determine if any blooms occurred in 1985.

Lower Tampa Bay occupies the mainstem of the estuarine complex and has water quality superior to the other two bays (Table 3-4). Since Lower Tampa Bay is closer to the Gulf, the nutrients are diluted more than in the other two bays. Sources of nutrient loading to the mainstem are also less concentrated.

Apalachicola Bay

Apalachicola Bay has a surface area of 214 square miles. The major river flowing into the Bay is the Apalachicola River, which has an average flow rate of 22,000 cfs and is the largest of all Florida rivers. The bay has been declared an Outstanding Florida Water and is the largest of the National Estuarine Sanctuaries. Water quality in the bay is good and supports one of Florida's major fishing and shellfishing industries. The most extensive damage to bay water in the recent past was caused by hurricanes Elena and Kate which occurred on September 2, 1985, and November 21, 1985, respectively. These storms elevated levels of suspended solids to the point that oyster bars were closed so the bars could recover from siltation and burial.

Water quality data in Apalachicola Bay are shown in Table 3-4. Water quality shows improvement in 1985 over the long-term average. The TSI was slightly lower in 1985, and material concentrations have all decreased. Secchi depth, however, is diminished in 1985. This may be a result of the two hurricanes that hit the bay.

Louisiana Gulf Coast

The Louisiana coast is the most turbid part of the Gulf coast due to the pervasive influence of the Mississippi and Atchafalaya Rivers. Plumes from these rivers extend many miles into the Gulf during high flow periods. Material from the plumes flows with longshore currents, which carry them westward. Constituents of the rivers' discharges have been traced as far west as the Texas/Mexico border.

Data from 2-15 km offshore along the Louisiana coast (Figure 3-7) were provided by the Louisiana Universities Marine Consortium (LUMCON). Due to the geomorphology of the coastline, many estuaries have large openings to the Gulf and mixing of fresh water with Gulf water may occur several kilometers out into

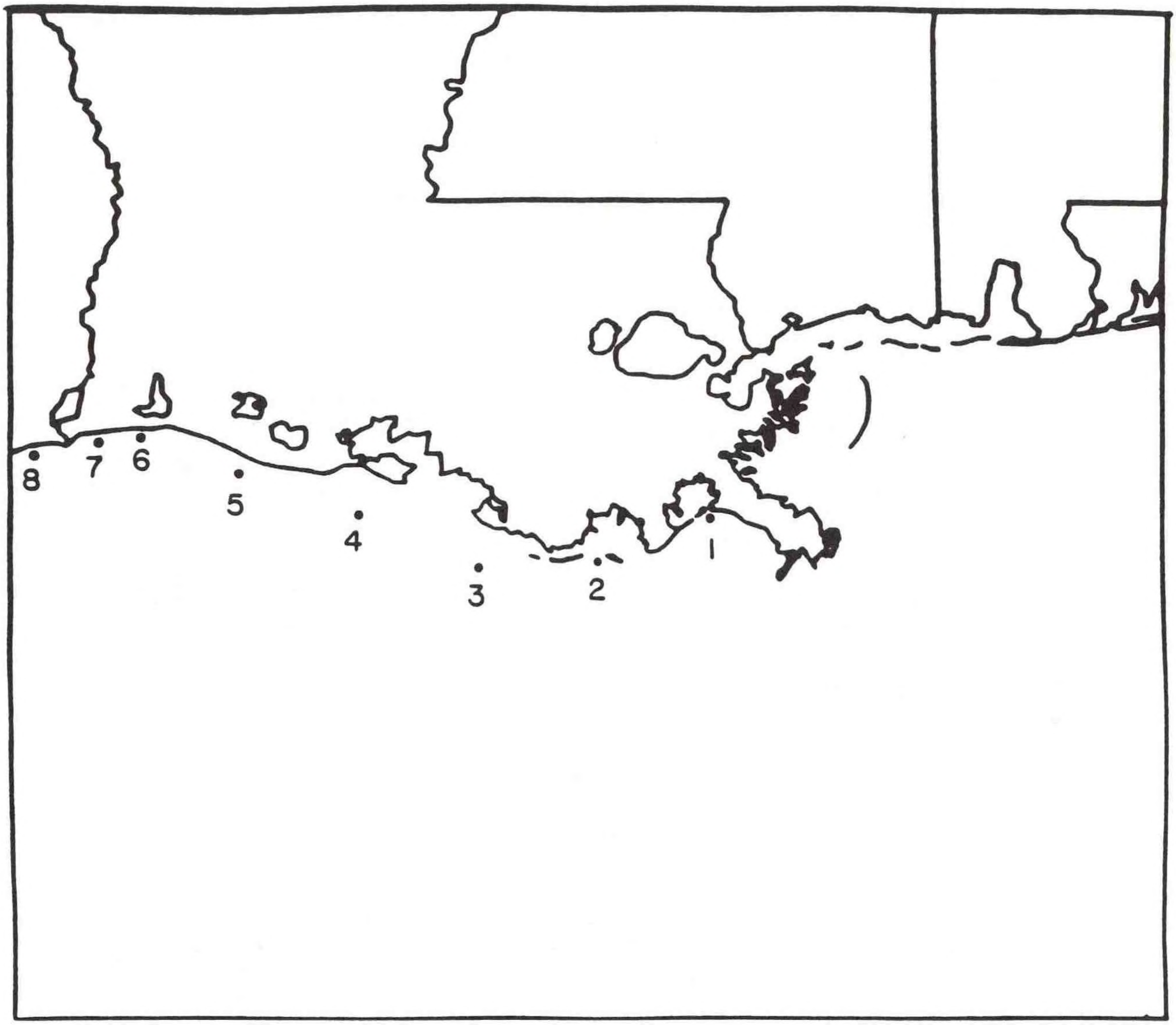

Figure 3-7.--Sampling locations along the Louisiana inner continental shelf.

the Gulf. This is particularly true for estuaries on the eastern half of the coast, from the Louisiana/Mississippi border to Vermilion Bay.

Estuaries on the western half of the coast have connections with the Gulf which are more restricted than those along the eastern part. Since these estuaries have less freshwater input, the influence of streamflow does not extend as far offshore as for the eastern estuaries.

Data from the Louisiana coast from two cruises, one in July and one in September, are shown in Tables 3-5 and 3-6. Materials sampled were secchi depth (SD), dissolved oxygen (D.O.), chlorophyll-a (Chl-a), ammonium (NH_3), nitrate (NO_3), and ortho-phosphate (PO_4). Nutrients were not sampled in September.

Nitrate concentrations ranged from .024 mg/l to .053 mg/l on the eastern part of the coast and from .003 mg/l to .011 mg/l on the western part. Since river water is the primary source of NO_3 to the coast, higher NO_3 concentrations occur where freshwater inputs are larger. Ammonium and PO_4 did not vary consistently from east to west or with distance from shoreline.

Dissolved oxygen and Chl-a were sampled in July and September. The stations furthest west, 7 and 8, were not sampled in September. Dissolved oxygen concentrations were higher in September than July at eastern stations 1, 2, and 3. The reverse is true for the more western stations 4, 5, and 6. Typically, D.O. is expected to be lower in summer than winter due to higher water temperatures and metabolic rates. In July the eastern half of the coast (stations 1-4) had D.O. values ranging from 5.43-6.30, while the western stations had a higher range of 6.26-7.57. The D.O. distribution in September was not uniform. It is worth noting, however, that September D.O. at station 1 was 11.77, a relatively high value.

In July, Chl-a value ranges were 8.09-12.40 on the eastern part of the coast and 2.22-4.17 on the western part. This indicates that primary productivity was higher in the east than west, which is due partially to increased nutrient availability from riverine sources. Fall distributions are patchy. Station 1 had an extremely high value of 42.73 micrograms per liter. High Chl-a and D.O. values indicate that an algal bloom might have been present at this station in September.

The data show a tendency for the differences between the eastern and western portions of the coast to be more pronounced in the summer than fall. River flow is typically greater in the summer than fall and may be influencing this regional gradient.

Texas Gulf Coast

The Texas Water Commission (TWC) has established nutrient guidelines by which to judge water quality in Texas. Since

Table 3-5.--Water quality on the Louisiana coast, July 15-20, 1985.

Station	D.O. (mg/l)	Chl-a (ug/l)	NH_4 (mg/l)	NO_3 (mg/l)	PO_4 (mg/l)	Dist.[(1)] (km)
1	6.29	12.29	.055	.053	.019	2
2	5.43	8.09	.066	.035	.012	3
3	6.30	9.59	.188	.053	.028	15
4	6.16	12.40	.020	.024	*	15
5	7.02	2.22	.108	.006	.028	10
6	7.59	4.17	.018	.003	.012	5
7	7.53	3.93	.077	.004	.022	5
8	6.26	2.56	.073	.011	.009	5

* Data are unavailable.

(1) Distance of sampling station from coast.

Data from Louisiana Universities Marine Consortium, Data Report No. 3.

Table 3-6.--Water quality on the Louisiana coast, September 10-13, 1985.

Station	D.O. (mg/l)	Chl-a (ug/l)
1	11.77	42.73
2	6.54	6.08
3	7.13	4.17
4	5.98	3.50
5	9.50	19.87
6	7.47	13.23

Data from Louisiana Universities Marine Consortium, Data Report No. 3.

guidelines are general and are the same for inland and coastal water bodies, they should not be viewed in a strict quantitative sense. The level of a nutrient is considered elevated if a critical limit was defined, and this limit was exceeded based on the following list:

Ammonium + Nitrate	>	1.0 mg/l
Total Phosphorous	>	.15 mg/l
Ortho-phosphate	>	.07 mg/l

Data for Texas estuaries were provided by the TWC. The estuaries reviewed are Sabine Pass, the Galveston Bay System, San Antonio Bay, the Corpus Christi-Nueces Bay System, the Lavaca-Matagorda Bay System, and Laguna Madre. Parameters discussed are dissolved oxygen (D.O.), total suspended solids (TSS), total ammonium nitrogen (NH_3), total nitrate nitrogen (NO_3), total phosphorous (TP), and ortho-phosphate (PO_4). Long-term concentration averages from 1970-1984 are compared with the 1985 annual averages. The long-term and 1985 data are shown in Table 3-7.

In the majority of estuaries reviewed, forms of nitrogen decreased in 1985, while forms of phosphorous increased or remained the same. Notable decreases in concentrations of total suspended solids also occurred in the majority of estuaries.

The TWC has established a ranking scale, based on EPA water quality criteria, for segments of all major water bodies in the state. The rank of each Texas estuary included in this report is given below. The scale range is from 1 to 311 (311 segments are monitored), where 1 represents the area of worst water quality in the state and 311 represents the best. The ranking method is based on the number of criteria violations of D.O., water temperature, pH, fecal coliform, chloride ion, sulfate ion and total dissolved solids. A criteria violation occurs when a parameter value falls outside the range of limits established by the EPA as being appropriate for a given water body. The ranks are included in this report as supplemental information, because, with the exception of D.O., the ranks are not based on parameters reviewed here. The ranks are as follows:

Lower Galveston Bay	83
Upper Galveston Bay	88
Laguna Madre	95
Trinity Bay	102
Lavaca Bay	126
Corpus Christi Bay	136
Nueces Bay	148
West Bay (Galveston)	157
East Bay (Galveston)	199
Matagorda Bay	208
San Antonio Bay	212
Sabine Pass	267

Table 3-7.--Water quality in selected Texas estuaries.

Estuary/ Time	D.O. (mg/l)	TSS (mg/l)	NH_3 (mg/l)	NO_3 (mg/l)	TP (mg/l)	PO_4 (mg/l)	Chl-a (ug/l)
Sabine							
1985	7.00	25.0	0.06	0.14	0.07	0.03	5.0
1970-1984	7.20	34.0	0.11	0.17	0.07	0.02	*
Upper Galveston							
1985	8.40	20.0	0.11	0.14	0.35	0.28	9.6
1970-1984	8.60	26.0	0.10	0.12	0.47	0.37	*
Trinity							
1985	9.00	20.0	0.18	0.28	0.30	0.23	6.2
1970-1984	8.80	43.0	0.23	0.11	0.50	0.29	*
Lower Galveston							
1985	8.40	19.0	0.08	0.07	0.18	0.12	8.5
1970-1984	8.10	31.0	0.12	0.08	0.32	0.18	*
East Bay							
1985	9.60	20.0	0.06	0.03	0.11	0.09	4.7
1970-1984	8.70	40.0	0.16	0.03	0.32	0.13	*
West Bay							
1985	8.30	26.0	0.05	0.05	0.12	0.07	7.4
1970-1984	7.90	38.0	0.14	0.03	0.17	0.10	*
Lavaca							
1985	8.70	37.0	0.03	0.02	0.07	0.05	5.7
1970-1985	8.20	47.0	0.11	0.12	0.07	0.02	*
Matagorda							
1985	8.90	27.0	0.06	0.08	0.10	0.07	4.0
1970-1984	8.00	42.0	0.10	0.12	0.06	0.02	*
San Antonio							
1985	7.70	67.0	*	0.04	0.16	0.14	9.0
1970-1984	8.50	54.0	0.11	0.13	0.14	0.09	*
Nueces							
1985	8.00	41.0	0.06	0.05	0.11	0.08	9.6
1970-1984	8.00	69.0	0.10	0.09	0.10	0.04	*
Corpus Christi							
1985	7.70	26.0	0.05	0.03	0.08	0.04	9.3
1970-1984	7.60	43.0	0.15	0.13	0.07	0.03	*
Laguna Madre							
1985	7.00	29.0	0.07	0.09	0.07	0.03	7.1
1970-1984	7.50	40.0	0.13	0.09	0.06	0.03	*

* Data are unavailable.
Data from Texas Water Commission.

Sabine Pass

Sabine Pass receives freshwater inflow from the Sabine River. In 1985, the nitrogen forms were lower than the long-term averages, while TP remained the same, and PO_4 increased slightly (Table 3-7). Total suspended solids in 1985 were considerably lower than the long-term average.

Galveston Bay System

The Galveston Bay System, with a surface area of approximately 535 square miles, is one of largest estuarine complexes along the Gulf coast. The primary sources of freshwater are the Trinity and San Jacinto Rivers. The bay may be divided into five subsystems: Trinity Bay, Upper Galveston Bay, Lower Galveston Bay, East Bay, and West Bay. Concentrations of nutrients are highest in Trinity and Upper Galveston Bays both in 1985 and over the long-term. In 1985, Upper Galveston Bay had the highest average concentrations of Chl-a, TP, and PO_4 of all the Texas estuaries. Trinity Bay had the second highest average concentrations of TP and PO_4 and had the highest NO_3 concentration of all Texas bays for 1985. Trinity and Upper Galveston Bays ranked first and second, respectively, for high NH_3 concentration.

In Upper Galveston Bay inorganic nitrogen forms were higher in 1985 than the long-term average. Both forms of phosphorous were lower in 1985 than the long-term average. Total suspended solids were lower by 6 mg/l, a smaller drop than was experienced by most other Texas estuaries. Upper Galveston Bay, however, had the lowest long-term TSS average of all the estuaries.

In Trinity Bay in 1985 NH_3 concentration was lower than the long-term average, but NO_3 was higher by .162 mg/l. This was one of the few bays in Texas where NO_3 increased in 1985. Total phosphorous was lower in 1985 by nearly .2 mg/l and PO_4 was lower but the difference was not as large. Both forms of phosphorous remained in the elevated category. D.O. was higher in 1985 by a moderate amount. Total suspended solids were lower by 23 mg/l from the long-term average, a substantial difference.

In Lower Galveston Bay in 1985 all nutrient concentrations decreased, but TP and PO_4 were considered elevated. Total suspended solids decreased by 12 mg/l in 1985. These changes indicate an overall improvement in water quality in Lower Galveston Bay in 1985.

East Bay experienced a very large drop in NH_3 concentration in 1985, while NO_3 did not change from the long-term average. Total phosphorous decreased markedly, and PO_4 decreased to a lesser extent. Total suspended solids concentrations were 50 percent below the mean. These changes indicate an overall improvement in water quality in East Bay in 1985.

In West Bay water quality showed an overall improvement in 1985 over the long-term average. Most nutrient levels decreased, with NH_3 showing a relatively large reduction. Only NO_3 increased, and that was by a slight amount. A large decrease in TSS concentration also occurred.

Lavaca-Matagorda Bay System

The Lavaca-Matagorda Bay System is fairly large, having a surface area of approximately 324 square miles, not including the numerous smaller offshoot bays. The Lavaca River is the primary source of freshwater to the system. Matagorda Bay is a particularly important resource to the commercial fishing industry in Texas.

In Lavaca Bay in 1985 both forms of nitrogen were lower than the long-term average. Total phosphorous concentration did not change, but PO_4 concentration more than doubled. TSS decreased by 10 mg/l in 1985.

In Matagorda Bay in 1985 both forms of nitrogen decreased, and both forms of phosphorous increased in concentration. Dissolved oxygen showed a moderate increase of .9 mg/l in 1985, and TSS showed a considerable decrease of 15 mg/l.

San Antonio Bay

The major source of freshwater to San Antonio Bay is the Guadalupe River and the surface area of the bay is about 205 square miles. The TWC designated San Antonio Bay as a priority area for water quality considerations, because population and development around the Bay are increasing rapidly. In 1985 San Antonio Bay experienced a 13 mg/l increase in TSS, while all other Texas estuaries showed decreases. A slight increase in TP pushed the Bay into the elevated catagory for this material in 1985. The long-term average for PO_4 is considered elevated, and concentration in 1985 was considerably higher than the long-term average. Dissolved oxygen concentration was lower in 1985. Nitrate was the only nutrient with a lower concentration in 1985. Overall, water quality degraded in 1985, reflecting the fact that the San Antonio Bay area is undergoing development.

Nueces-Corpus Christi Bay System

The Nueces-Corpus Christi Bay system, with a surface area of 192 square miles, is the smallest of the Texas estuaries reviewed. The principal source of freshwater to the system is the Nueces River, which has an annual average flow rate of less than 1000 cfs. The low annual river flow combined with a small tidal range cause periodic nutrient depletion. Among the Texas estuaries reviewed, Corpus Christi Bay had the lowest average concentrations of NO_3, second lowest concentration NH_3, and ranked third lowest for TP and PO_4. Nueces Bay, being closer to the source of freshwater, had higher concentrations of all materials.

In Nueces Bay in 1985, both forms of inorganic N were lower than the long-term averages. Total phosphorous and PO_4 were slightly higher in 1985. Ortho-phosphate was considered elevated for 1985. Total suspended solids were lower by 28 mg/l in 1985, a substantial drop from the long-term average.

In Corpus Christi Bay in 1985 forms of inorganic N were considerably lower than the long-term averages. However, both forms of phosphorous were higher. Total suspended solids concentration was lower by 60 percent in 1985.

Laguna Madre

The major source of freshwater to Laguna Madre is the Arroyo Colorado in the south and smaller streams flowing into the adjacent Baffin Bay in the north. It is one of the largest estuaries along the coast with a surface area of 582 square miles. Ammonium concentration in 1985 was lower than the long-term average, and NO_3 remained the same. Total phosphorous increased and PO_4 remained the same. D.O. was slightly lower in 1985. Total suspended solids were considerably lower in 1985. With the exception of the TSS decrease, water quality in 1985 was similar to the long-term average.

3.4 Surface Water Salinity and Temperature

Surface water salinity and temperature were evaluated for the selected National Ocean Service (NOS) stations depicted in Figure 3-8. Tables 3-8 and 3-9 give the long-term mean salinities and temperatures and the 1985 departures from these normal values.

Salinity

Following the description of the long-term seasonal salinity patterns at the selected NOS stations, the monthly mean surface salinity distributions during 1985 will be discussed.

Stations between Naples and Cedar Key, FL, normally experience salinity maxima in May or June and minima in September. Secondary maxima occur in late fall or winter, and secondary minima occur in early spring. Stations from Cedar Key north and west to Grand Isle, LA, normally experience salinity maxima in November and minima in spring. Stations farther west experience salinity minima later than stations in the eastern Gulf. Secondary maxima and minima occur at these western Gulf stations in the summer months of some years.

From Galveston to Port Mansfield, TX, the salinity patterns

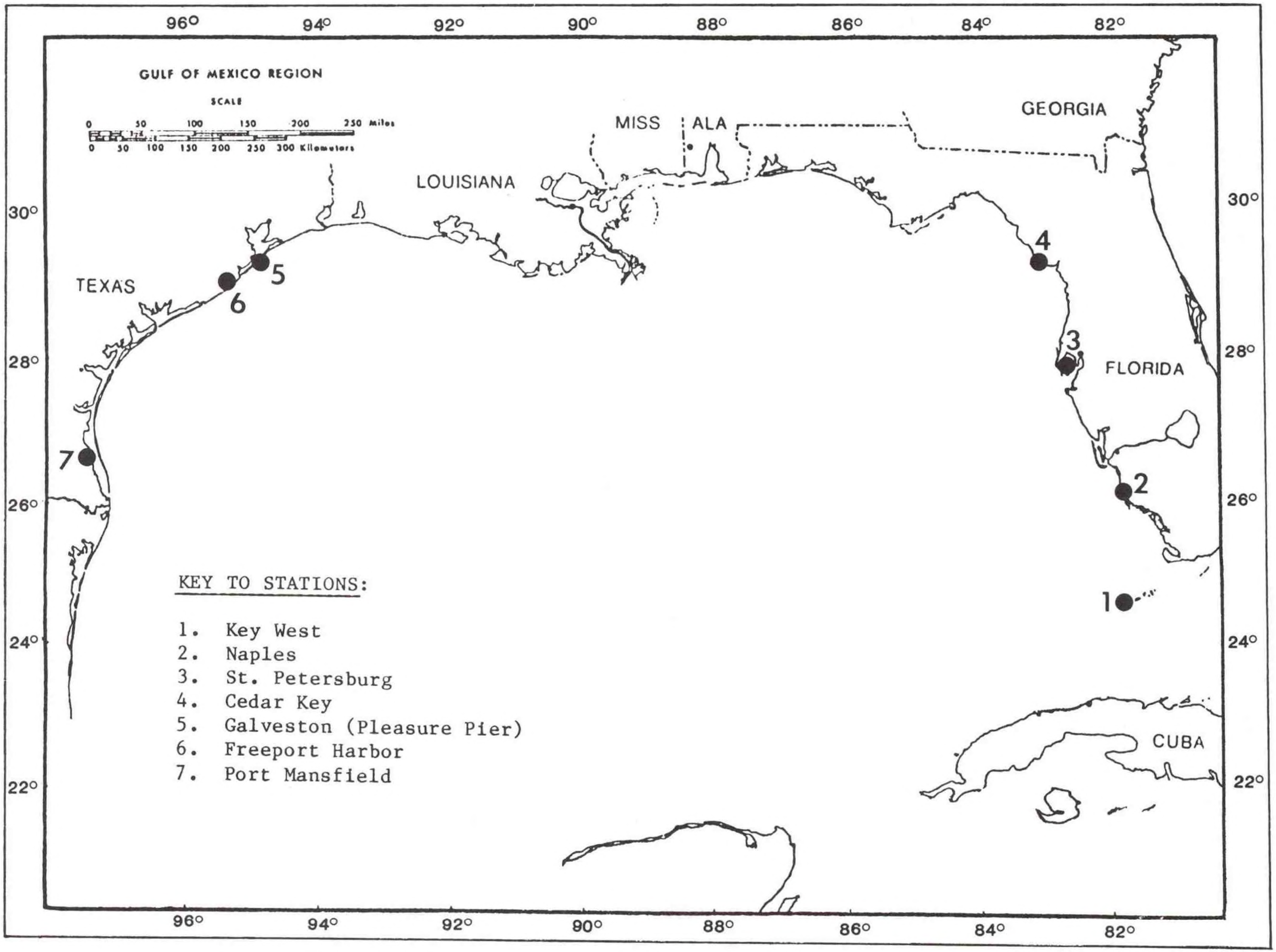

Figure 3-8.--Selected National Ocean Service temperature and density stations, Gulf of Mexico.

show maxima in August and minima in May with secondary maxima in November following slight secondary minima in October. The salinity cycles reflect the general circulation of the Gulf of Mexico and local responses to freshwater runoff.

Salinities were consistently above normal for all sites around the Gulf in 1985. Rainfall for the selected NWS sites showed a yearly excess, except for the region from Tallahassee to Fort Myers, FL. For the non-Florida NOS stations, rainfall and streamflow do not appear to explain the departures from normal, while for the Florida sites salinities were apparently responding to the general lack of precipitation.

Key West, FL, did not have an entire year's worth of monthly mean data for 1985, but the available data closely followed the expected yearly cycle with a maximum anomaly of 1.7 parts per thousand (ppt). There was a decrease in salinity in April that was probably due to precipitation that was 611 percent above normal. The summer increases could have resulted from reductions in local precipitation or to external factors such as the Loop Current.

Naples, FL, had elevated salinities from 1.5 to 4.8 ppt above the mean for the entire year. These elevated values could be the result of reduced rainfall, assuming that the Fort Myers precipitation data are representative of the Naples area.

St. Petersburg, FL, data were consistently elevated above the mean, but followed the expected yearly cycle. There appears to be a linear offset in the data of 3 ppt. Rainfall data for Tampa do not appear to account for these elevated values.

Cedar Key had a partial year's worth of data that showed reduced salinities in the winter and elevated values during the spring and summer. The March and April normal minimum did not occur in 1985. This was probably due to reduced regional precipitation, which continued throughout the period of record for Cedar Key.

Galveston's limited dataset had consistently elevated salinities compared to the mean, but followed the expected annual cycle. Summertime maxima were approximately 4 to 6 ppt above normal. Streamflow, precipitation, and wind-induced mass transport data do not appear to account for these departures.

Freeport, TX, basically followed the mean seasonal pattern with above-average salinities during the late spring and early summer due to reduced streamflow from the Brazos River. A dramatic reduction in surface salinities in late 1985 probably resulted from the above-normal streamflow in the Brazos River.

The limited dataset for Port Mansfield showed greatly reduced salinities compared to the mean yearly cycle. Reductions in measured values ranged from approximately 2 ppt in June to 11

Table 3-8.--Monthly long-term average surface salinity and departure from normal, selected stations, Gulf of Mexico, 1985.

A. Monthly long-term average (ppt)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
	Month												
Key West	36.0	36.2	36.4	36.7	37.0	36.6	36.7	36.7	36.2	35.8	36.3	36.2	36.4
Naples	35.7	35.7	36.2	35.3	36.0	35.8	35.3	34.5	33.7	34.2	34.8	35.0	35.2
St. Petersburg	26.8	26.7	26.4	26.5	27.8	28.8	28.0	25.4	23.4	23.9	25.6	26.5	26.3
Cedar Key	27.1	26.0	24.7	24.7	26.0	27.5	27.1	25.9	25.6	26.1	27.5	27.3	26.3
Galveston (Pleasure Pier)	29.1	29.1	28.4	26.1	24.8	28.2	31.8	33.3	28.6	28.5	29.7	29.5	28.9
Freeport Harbor	24.7	24.1	25.8	25.2	23.3	26.0	30.4	33.1	28.4	25.1	25.9	25.1	26.4
Port Mansfield	34.8	35.0	35.3	35.4	33.6	33.3	36.4	40.3	39.8	37.6	38.6	37.1	36.4

Table 3-8 (Continued).--Monthly long-term average surface salinity and departure from normal, selected stations, Gulf of Mexico, 1985.

B. Departure from normal, 1985 (ppt)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Month											
Key West	**	**	1.5	0.1	0.8	1.7	1.7	**	0.0	0.7	0.1	0.3
Naples	1.5	2.2	2.2	3.4	3.4	4.0	3.5	3.3	4.8	3.5	2.5	2.5
St. Petersburg	2.7	2.8	3.1	3.8	3.4	3.0	3.8	5.3	2.6	2.6	2.3	2.5
Cedar Key	-1.6	-0.4	3.4	2.9	2.1	0.8	2.0	*	*	*	*	*
Galveston (Pleasure Pier)	**	0.4	0.7	4.5	**	5.8	3.7	4.7	5.2	2.0	1.1	**
Freeport Harbor	-0.2	-0.8	1.1	-2.1	1.7	4.8	0.3	3.3	2.5	1.2	-4.1	-5.6
Port Mansfield	-5.1	-2.4	-7.6	-5.5	-3.6	-2.3	**	**	**	**	-10.9	**

* Data unavailable.

** Insufficient number of days of data to generate a monthly mean.

Table 3-9.--Monthly long-term average surface water temperature and departure from normal, selected stations, Gulf of Mexico, 1985.

A. Monthly long-term average (Degrees C)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Key West	21.7	22.1	23.7	25.8	27.9	29.6	30.4	30.6	29.7	27.6	24.4	22.3	26.3
Naples	18.1	18.1	19.9	24.8	27.5	29.8	30.7	30.6	29.4	27.6	22.2	19.9	24.9
St. Petersburg	16.7	17.6	19.7	23.1	26.4	28.8	29.7	29.7	28.7	25.4	21.0	17.6	23.7
Cedar Key	14.4	15.7	18.4	22.9	26.4	29.1	29.8	29.8	28.3	24.2	19.0	15.4	22.8
Galveston	11.9	12.8	15.7	21.4	25.4	28.3	29.7	30.0	28.3	24.4	19.3	14.9	21.8
Freeport Harbor	11.9	13.5	16.2	21.4	25.1	27.7	28.7	29.3	27.9	23.8	18.9	14.9	21.6
Port Mansfield	14.6	16.1	18.6	23.8	26.1	28.3	29.2	29.2	28.3	24.6	20.7	16.7	23.0

Table 3-9 (Continued).--Monthly long-term average surface water temperature and departure from normal, selected stations, Gulf of Mexico, 1985.

B. Departure from normal, 1985 (Degrees C)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Key West	**	**	0.2	-0.9	0.9	0.4	-0.3	**	-1.1	1.0	1.5	-0.8
Naples	0.4	0.1	3.1	0.0	1.1	0.8	-0.6	0.1	-0.8	0.8	3.0	0.4
St. Petersburg	-0.6	-0.2	1.9	0.3	0.8	1.3	0.8	1.1	-0.6	2.5	3.7	0.8
Cedar Key	-2.0	0.7	3.1	0.6	0.9	-0.1	0.4	*	*	*	*	*
Galveston	0.3	-1.2	2.5	0.8	0.7	-1.0	-0.7	0.0	0.0	-1.4	1.5	-0.9
Freeport Harbor	0.3	-1.9	2.5	0.7	0.9	-0.6	0.1	0.5	0.6	0.9	2.5	-0.8
Port Mansfield	-3.0	-2.6	2.5	-0.8	0.8	0.0	-0.4	0.5	0.3	-0.3	1.6	-1.6

* Data unavailable.

** Insufficient number of days of data to generate a monthly mean.

ppt in November. However, streamflow for the Rio Grande was below normal for the entire year, and rainfall at Brownsville was not substantially elevated during the times of coincident data to account for these anomalies.

Temperature

Water temperatures at the NOS Gulf stations followed the long-term seasonal patterns with no apparent temperature anomalies. The winter minimum temperatures occurred in January. With increasing solar insolation, warming began in February and quickly accelerated in April and May. The temperatures increased more slowly during June and July, reaching the yearly maxima in July or August. Cooling began in September and accelerated during October and November. In December, the cooling slowed, and the temperatures approached the yearly minima. Since cold continental air masses passed more frequently through the western Gulf than the eastern Gulf, the winter minimum temperatures at the western Gulf stations were lower than those measured at the eastern Gulf sites. Eastern Gulf temperatures can be modified by the warm Loop Current, which acts as a heat source. The summer maximum temperatures reached were nearly the same at the NOS stations sampled.

3.5 Wind-Induced Mass Transport

The Assessment and Information Services Center has computed wind-driven mass transport estimates based upon the National Weather Service Limited-area, Fine-mesh Model (LFM) - II dataset. The transport values are not absolute magnitudes of the transport, but are relative magnitudes and directions of the wind-induced surface layer transport. Since commercial species in the Gulf such as menhaden and shrimp spawn offshore and rely on wind-driven transport to convey larvae into estuarine nursery areas, the patterns of transport at the critical times are important for estimating survival of year classes. Thus, if in March shrimp spawn off the Texas coast, and the larvae must be transported to the nursery grounds along the Texas coast, onshore transport would favor the survival of these shrimp larvae. If the transport were stronger (weaker) than normal, and the other environmental and biological factors were normal, a probable increase (reduction) in that shrimp year class would be expected.

Figure 3-9 shows the mean monthly transports computed for 1985 and for the eight-year period 1977-84. The units are expressed as cubic meters per second per meter of baseline length normal to the wind vector so as to be comparable to previous similar computations in the literature.

The wind-induced circulation in the Gulf is divided geographically into five areas for this discussion: west Florida Shelf, northeast Gulf, northwest Gulf, southeast Texas coast, and the Mexican coast. The following discussion will address the regional transports and their comparisons to the monthly 1977-84

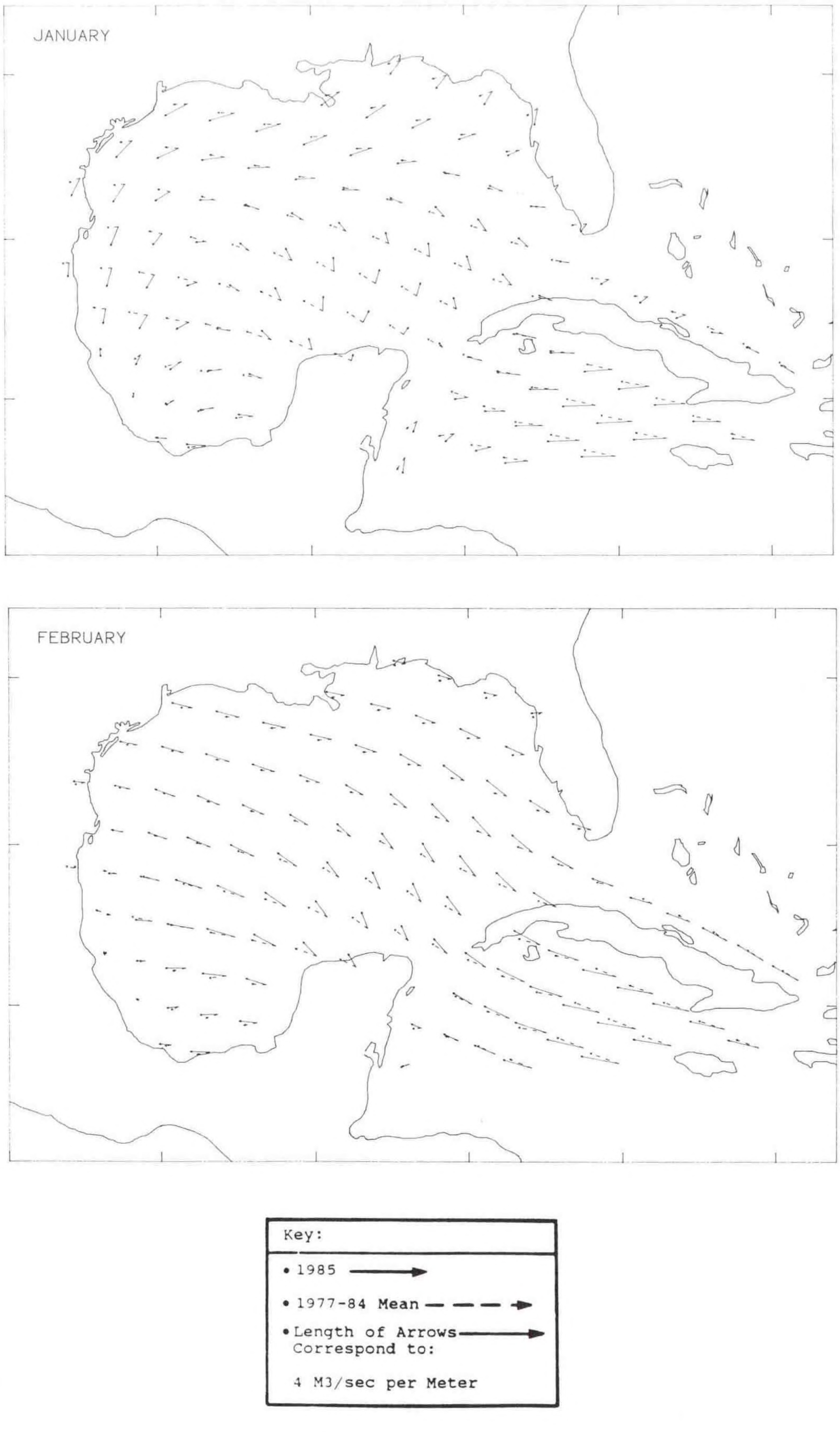

Figure 3-9.--Mean monthly mass transport, 1985, and 1977-1984.

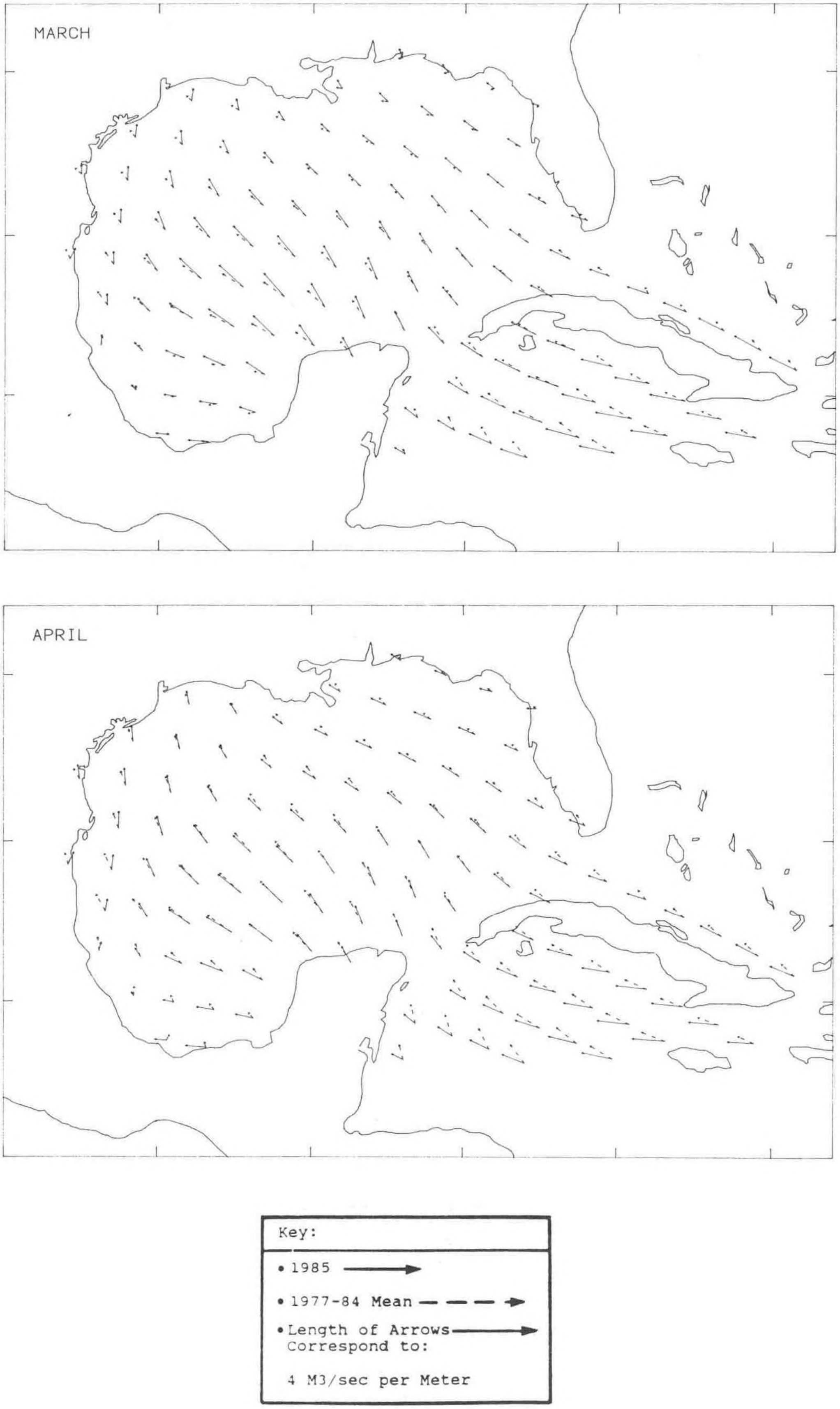

Figure 3-9 (continued).--Mean monthly mass transport, 1985, and 1977-1984.

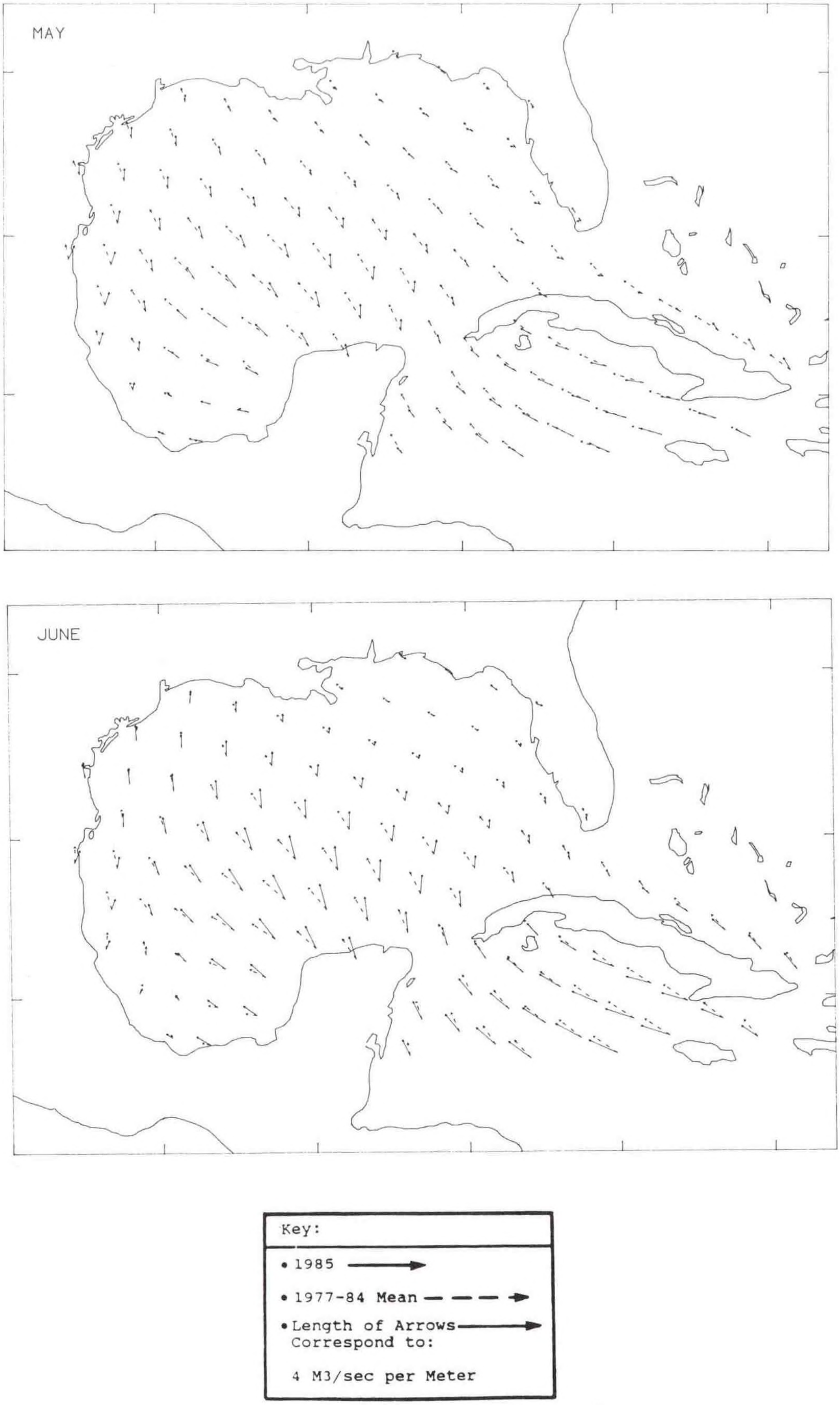

Figure 3-9 (continued).--Mean monthly mass transport, 1985, and 1977-1984.

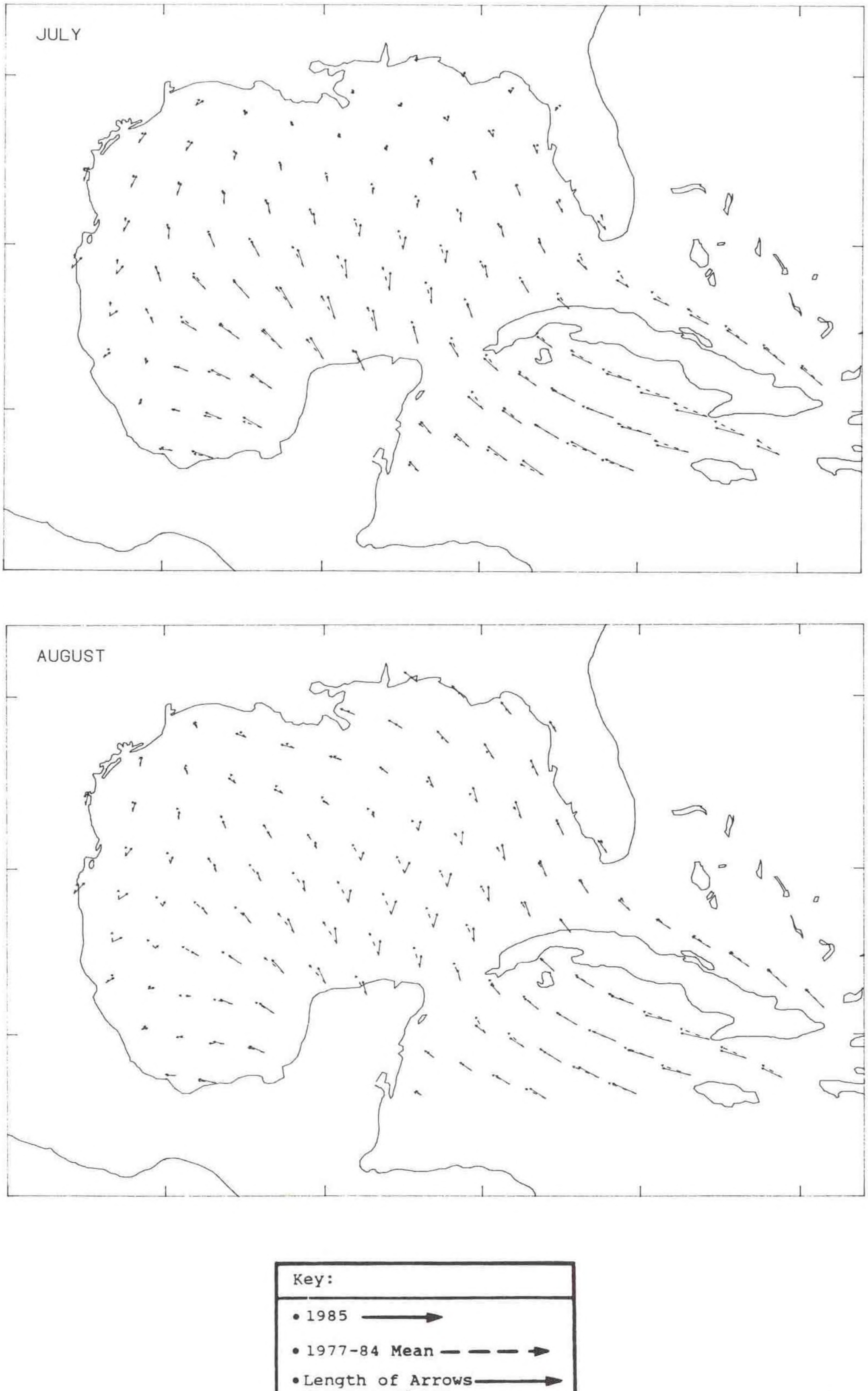

Figure 3-9 (continued).--Mean monthly mass transport, 1985, and 1977-1984.

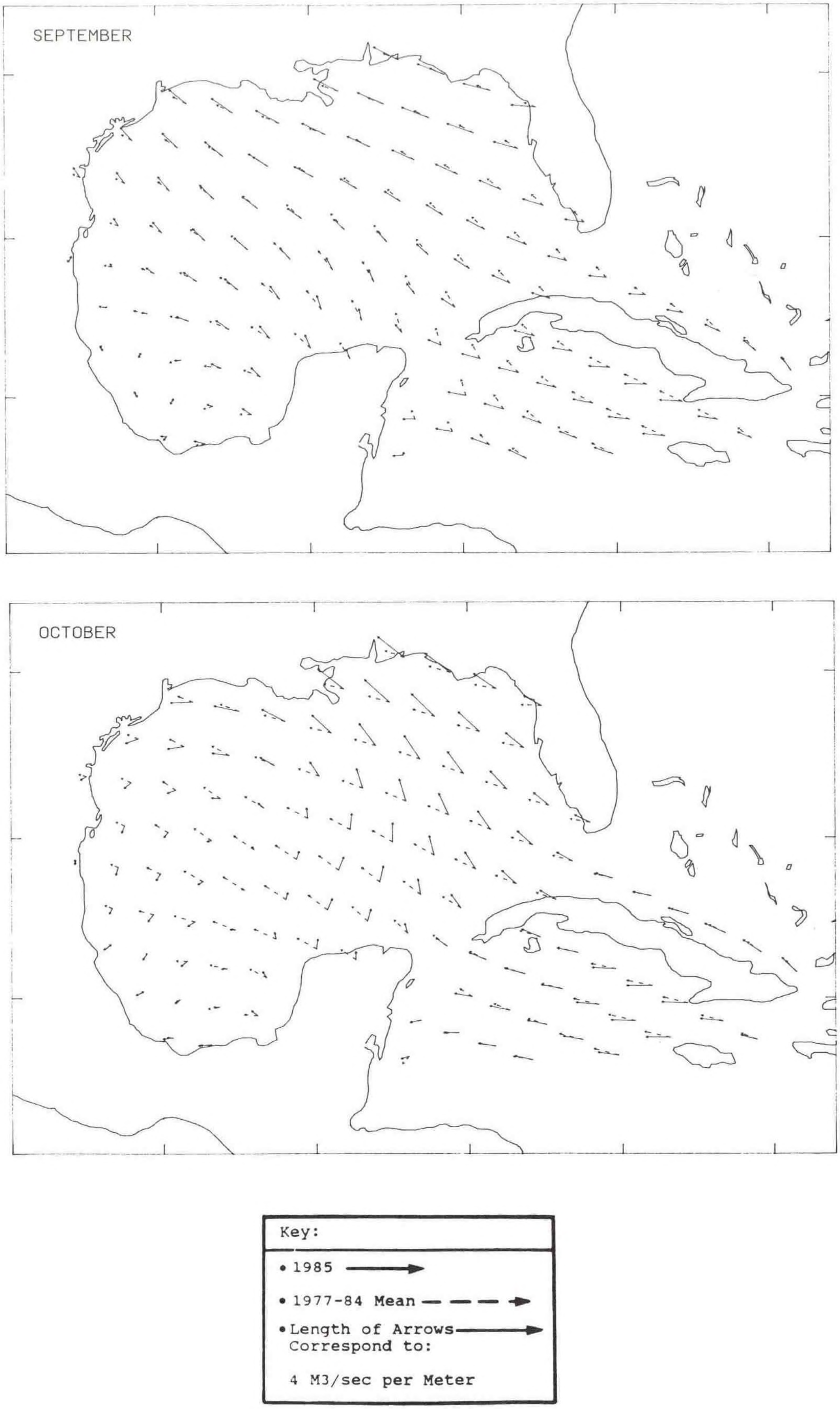

Figure 3-9 (continued).--Mean monthly mass transport, 1985, and 1977-1984.

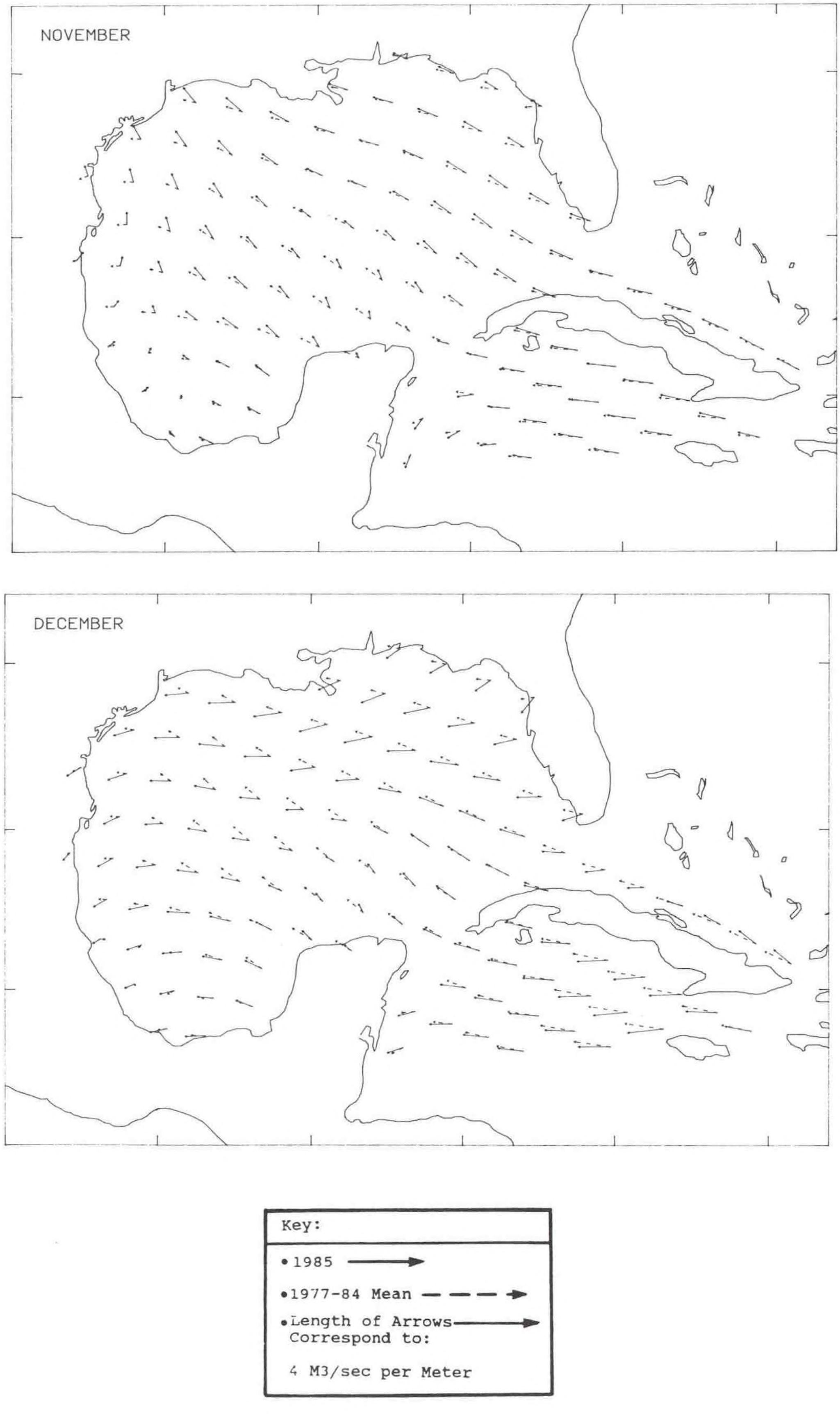

Figure 3-9 (continued).--Mean monthly mass transport, 1985, and 1977-1984.

normals on a monthly basis for calendar year 1985.

The Campeche Bay, Mexico, and the Caribbean LFM - II dataset was initially stored starting in June 1982. Thus, any comparisons of the Campeche Bay 1985 data to the monthly mean must be considered limited due to the lack of a climatological mean for this area.

Monthly Mass Transports

Cyclonic flows of surface waters from the Yucatan Straits westward to the Mexican coast dominated the January 1985 predictions of wind-induced mass transports and were in sharp contrast to the 1977-84 mean west to west-northwestward flows for the entire Gulf. Stronger and more offshore flows than the means were predicted for the northern coastal areas and became oriented with the westward-directed mean flows, but were higher in magnitude farther offshore. The Florida coastal stations were of similar magnitude to the means and were directed offshore, but with an increased southern component.

The February estimates of mass transports were comparable in direction to the mean west to northwest flows, but were higher in magnitude. Stronger and slightly offshore (more northerly) flow was predicted for the Florida coastal stations. The overall magnitude of the offshore flow agreed with the mean and decreased from the south to the north. The slightly onshore (more northerly) flows continued along the Gulf coast to Galveston, TX. A northward ridge in the northwestward flows was evident to the north of the Yucatan Peninsula.

March 1985 had stronger-than-normal transports for most of the Gulf, while the directions of the flows were comparable. Stronger-than-normal offshore (northwestward) flow along the Florida Gulf coast became onshore (north-northwestward) from the Florida panhandle to Louisiana. More northward flows were predicted for the Texas coast and from the Mexican coast to the Campeche Bay region. The northwestward to north-northwest flows of the deepwater regions of the Gulf were similar to the means, although slightly stronger. The westward flows of Campeche Bay were much stronger than the means.

The wind-induced transports for April 1985 were very similar to the 1977-84 monthly means. West-northwestward flows along the southern Florida coast were slightly more offshore (southerly) than the means, while along the northern Florida coast strong offshore (westward) flows were predicted. From the Florida panhandle to Mississippi stronger-than-normal alongshore and slightly onshore (west-northwestward) transports prevailed. From Louisiana to Corpus Christi, TX, normal onshore flows were predicted. Longshore (northward) flows characterized the Mexican coastal vectors. Northwestward flows dominated the eastern Gulf, while more northward flows were forecast in the Yucatan Straits area. North-northwestward flows were predicted for the western

Gulf, except in Campeche Bay, where strong westward flows dominated instead of the weak north-northwestward flows seen in the mean data.

May's transports were weaker than the mean for the entire Gulf of Mexico, except in Campeche Bay, where they were comparable to the means. Slight offshore (westward) flows were predicted for the Florida coast, instead of strong alongshore (north-northwestward) mean flows. Reduced onshore flows were predicted from the Florida panhandle to Texas. Reduced north to north-northwest flows along the Mexican coast were also predicted. These reductions in northward flow along the Mexican and Texas coasts could have reduced the advection of warmer, more saline waters from Mexico onto the Texas and western Louisiana shelves. The expected strong north-northwestward flows in the deepwater regions of the Gulf were reduced in magnitude but comparable in direction to the means, except for the Yucatan Straits area, where moderate north-northwest to north-northeastward flows were predicted.

The magnitude of the wind-induced transports for June were generally similar to the means, while the directions were generally within 45^{o} of these means. The Florida coast had reduced longshore (northward) flows, while southwestward flows were predicted for the area north of Tampa and along the Florida panhandle. A convergence zone might have been produced by these flows, but their magnitudes were small. The southwestward flow was almost in the opposite directions to the expected mean flows. Almost onshore flow was predicted for the near offshore set of vectors from the Florida panhandle to the mouth of the Mississippi River. The flows along western Louisiana and Texas were more normal with moderate onshore (northward) flows. The Mexican coast had slightly-reduced, alongshore (northward) flows. More northward flows were again predicted for the Yucatan Straits area as well as for the western and eastern Gulf of Mexico. The vectors in the western half of the Gulf had larger magnitudes for June 1985 and in the mean than the eastern half of the Gulf.

Near-normal directions and magnitudes characterized the July 1985 predicted mass transports. Moderate alongshore flows along Florida changed to slight onshore flows north of Tampa. Due to the coastal geography the northward flows along the Florida panhandle became slight onshore flows. North-northeastward flows were predicted for the Mexican coast, while more northward flows were forecast along the Texas coast. Flow in the northward direction aids the transport of warm, saline Mexican coastal waters northward to the eastern Texas and western Louisiana shelf region. Slight to moderate northward flows were predicted for the deepwater regions of the central, eastern, and western Gulf. The usual westward flows were predicted for the Campeche Bay region.

In August, stronger-than-normal flows were predicted for the majority of the coastal regions, while reduced transports were predicted for the deepwater portions of the Gulf. Augmented alongshore (north-northwestward) flow along Florida rotated cyclonically to be alongshore (westward) flow in western Louisiana. The mean alongshore (northward) flow for western Texas was predicted as was the onshore flow near Galveston. The Mexican coast had more offshore (northeastward) flows predicted than the expected alongshore (northward) flows. Increased eastward components of flow were predicted for the Yucatan Straits and the eastern Gulf of Mexico, while the western Gulf had reduced flow with similar directions compared to the mean.

Stronger-than-normal west-northwestward flows dominated the northern Gulf of Mexico in September 1985, while the remainder of the Gulf had near-normal conditions. The southern Florida coast had more offshore directed and stronger westward flow than normal, while the panhandle region had stronger-than-normal alongshore (westward) flows. Stronger-than-normal onshore (northwestward) flows were predicted for the Louisiana and Texas coasts. Slight northwestward flows of the Mexican coastal vectors at the Texas border rotating cyclonically to downcoast (southwestward) flows by Campeche Bay were as expected. While cyclonic flows were predicted for most of Campeche Bay, slight westward flows were predicted for its southern coastal stations. Reduced north-northwestward flows were predicted for the central Gulf region north of the Yucatan Peninsula.

Cyclonic wind-induced transports characterized the Gulf flows in October 1985, instead of the steady westward flows seen in the means. Reduced offshore flows were predicted for the southern Florida coast. The predicted flows were stronger-than-normal alongshore and slightly onshore (northwestward) for the panhandle region. Stronger-than-normal northward components of transports were predicted for the region from eastern Louisiana southward through the central Gulf. The transport vectors nearest to the coast of western Louisiana and eastern Texas compared favorably to the mean with moderate west-northwestward flows. The cyclonic turning of the coastal vectors southward along the Texas and Mexican coasts was predicted, instead of the onshore (westward) flow seen in the mean. The western Gulf had greatly reduced flows and flow directions coinciding with a low-pressure trough that was located between the Yucatan Peninsula and the Mexican coast and extended northward to the Texas/Louisiana coast.

Moderate northwest flows were predicted for the eastern and central Gulf, while more northward flows were depicted for the Yucatan Peninsula and Texas/Mexican coastal regions in November. Moderate offshore flows in southern Florida decreased in magnitude northward to the panhandle region and became directed more alongshore due to the coastal geography. Moderate onshore flows in the Mississippi Delta region compared favorably to the means. Increased northward components of flow were predicted for the Texas and Mexican coastal vectors, instead of the more westward-directed flow of the mean. Thus, the transport of warm, saline Mexican coastal waters northward could have occurred this month. Campeche Bay had a possible region of convergence where the offshore flows from the Mexican coast met the offshore (westward) flows from the Yucatan Peninsula. Decreased magnitudes and more northward directed flows were predicted north of the Yucatan Peninsula.

Increased magnitudes of southwestward flow characterized the eastern and northern Gulf of Mexico, while the remainder of the Gulf had near-normal directions and magnitudes of wind-induced transports in December. Stronger-than-normal southward components of flow resulted in west-southwestward flow along the southern Florida coast, while offshore (southwest) flow, not the normal westward flow, was predicted for the panhandle and Apalachee Bay. The Mississippi Delta region had onshore flow, which was increased in magnitude from the mean and with a southern component. Strong alongshore (westward) flow was predicted for the Texas/Louisiana region, which is contrast to the normal onshore (northwestward) flow. Cyclonic rotations in flow directions in the western Gulf were predicted with increased magnitude for the coastal vectors along the Mexican Coast. Reductions in flow were again predicted for the region north of the Yucatan Peninsula.

3.6 Loop Current Activities

The circulation in the eastern Gulf of Mexico is dominated by the Loop Current. This current is a continuation of the Caribbean Current, which enters the Gulf between the Yucatan Peninsula and Cuba (Figure 3-10). The following discussion of the 1985 monthly pattern of the Loop Current and warm core eddies within the Gulf of Mexico was derived from the Oceanographic Monthly Summary published by NOAA. Figure 3-11 is a series of line drawings of the monthly northern limit of the Loop Current.

The Loop Current and the eddies within the Gulf of Mexico affect the water column circulation and water mass properties for an area that extends beyond the observed boundary between the eddy or Loop Current and the surrounding waters. When the Loop Current or an eddy extends onto the shelf region of the Gulf the circulation on the nearby shelf is changed as the shelf waters are dragged by friction by the strong Loop or eddy circulation. A fishery that depends on spawning on the shelf and the subsequent movement of eggs or juveniles into coastal nursery areas can be affected by the Loop Current. If an eddy or filament drags the shelf waters away from the necessary nursery grounds, the fishery could be adversely affected by a reduction in the year class. This reduction in the stock will have an impact as the year class becomes available for harvest.

February through May 1985 saw extensive Loop Current and eddy activity along the shelf from Florida to Louisiana. One could expect strong mixing processes across these frontal boundaries of the Loop Current/eddies and the shelf waters and

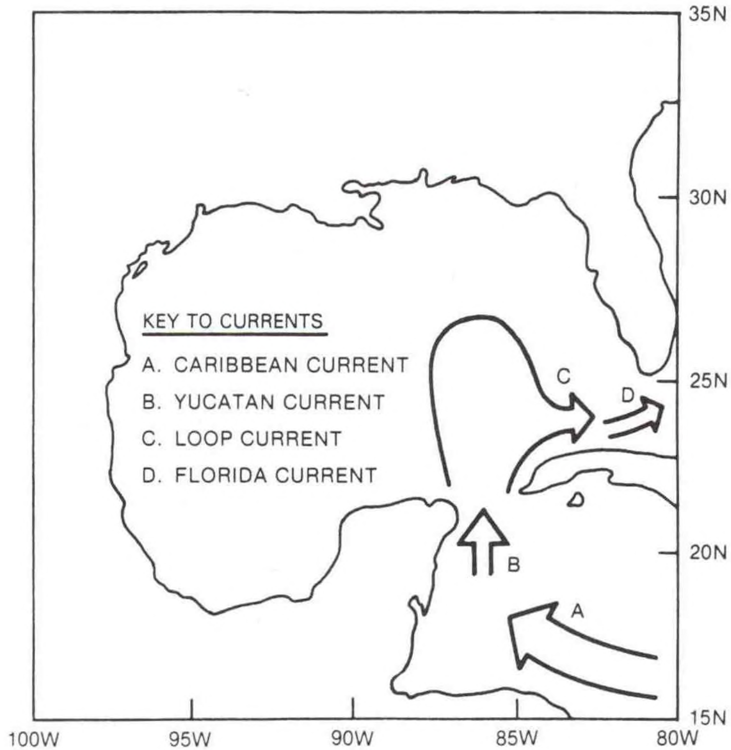

Figure 3-10.--Schematic of major density-driven mass transport in the Gulf of Mexico.

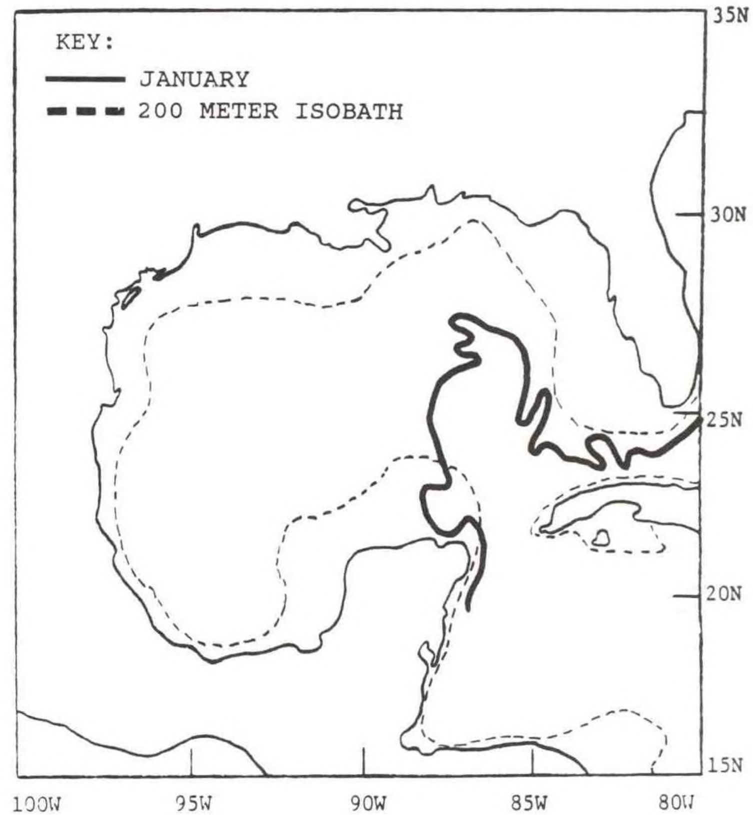

Figure 3-11.--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: January, 1985.

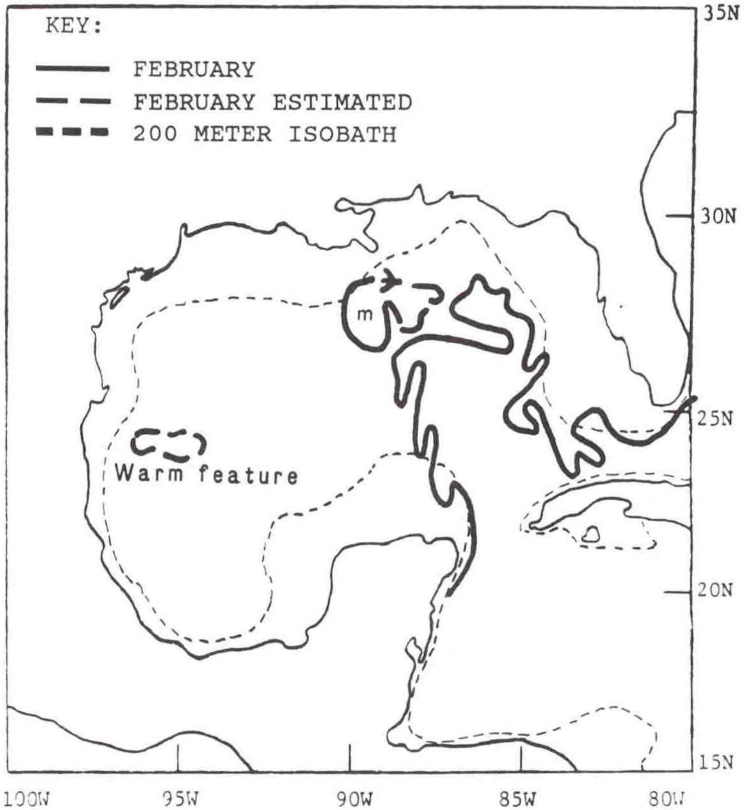

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: February, 1985.

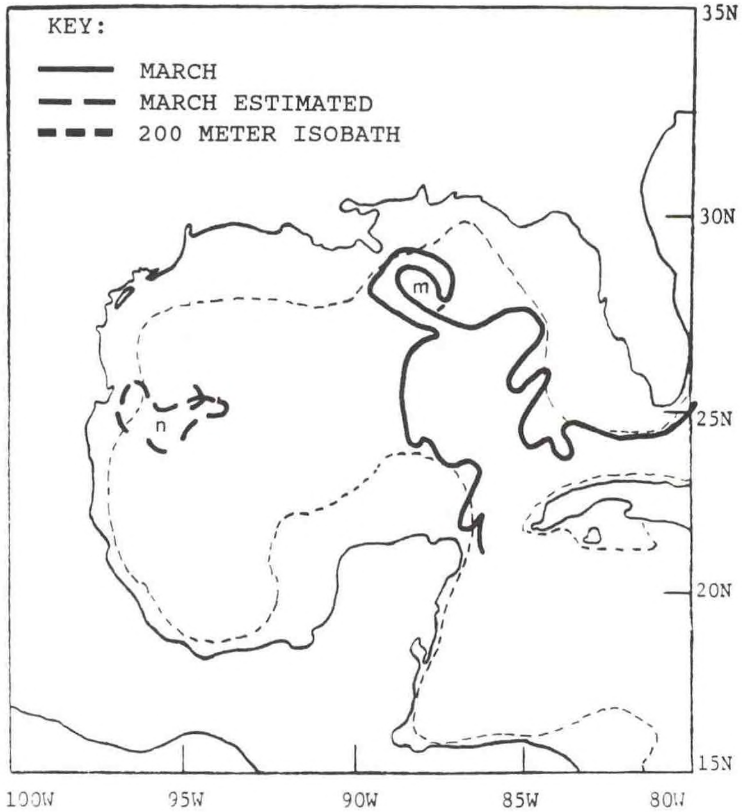

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: March, 1985.

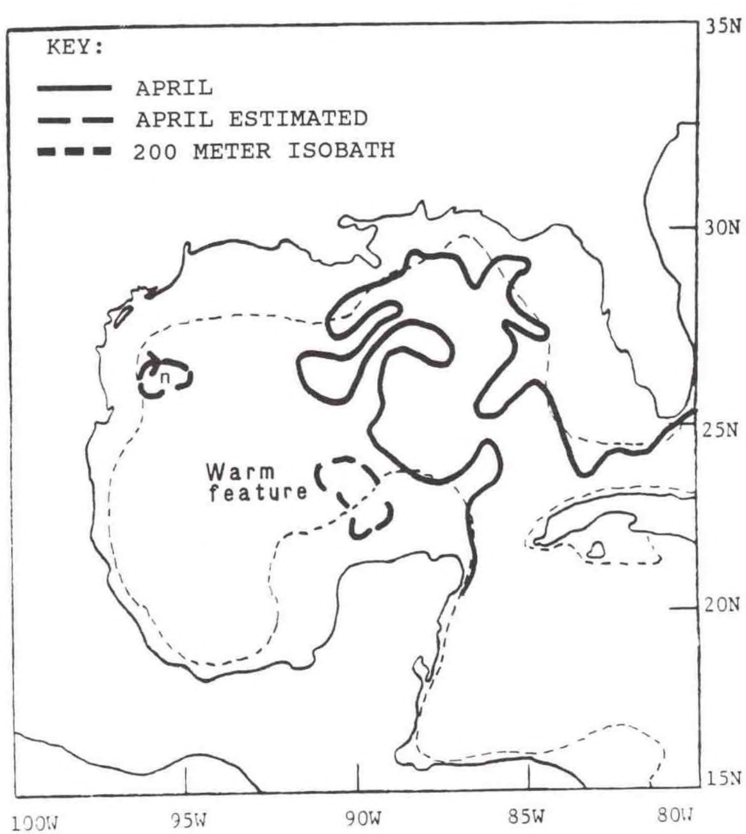

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in <u>Oceanographic Monthly Summary</u>: April, 1985.

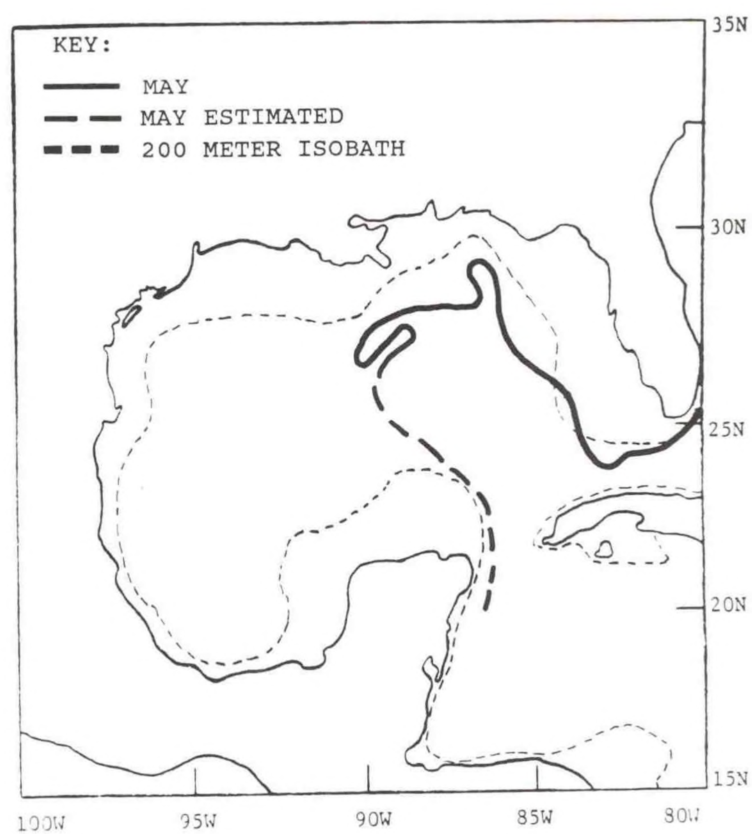

Figure 3-11.--Northern extent of the Loop Current. Figure drawn from material in <u>Oceanographic Monthly Summary</u>: May, 1985.

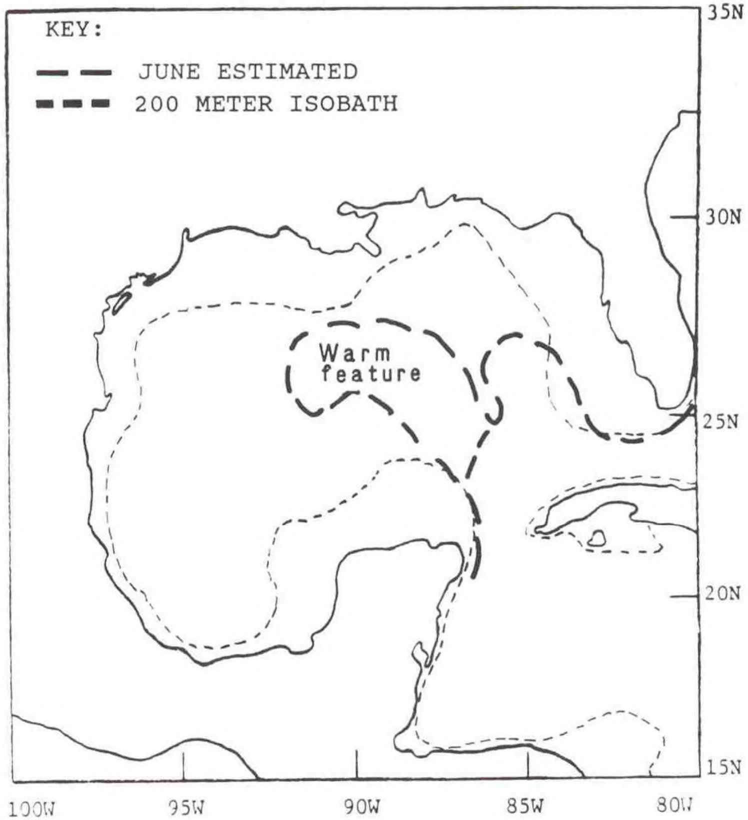

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: June, 1985.

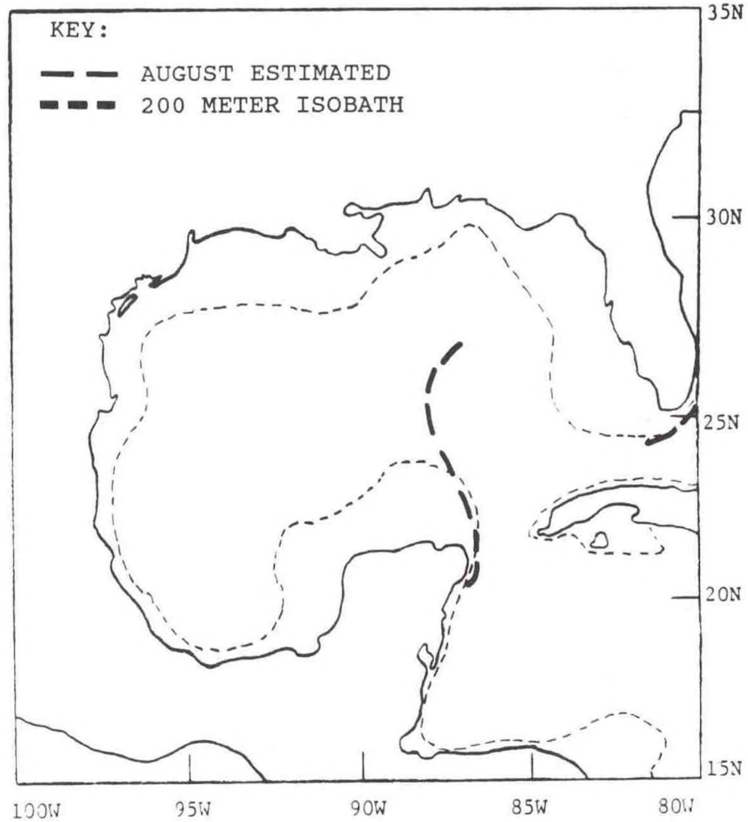

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: August, 1985.

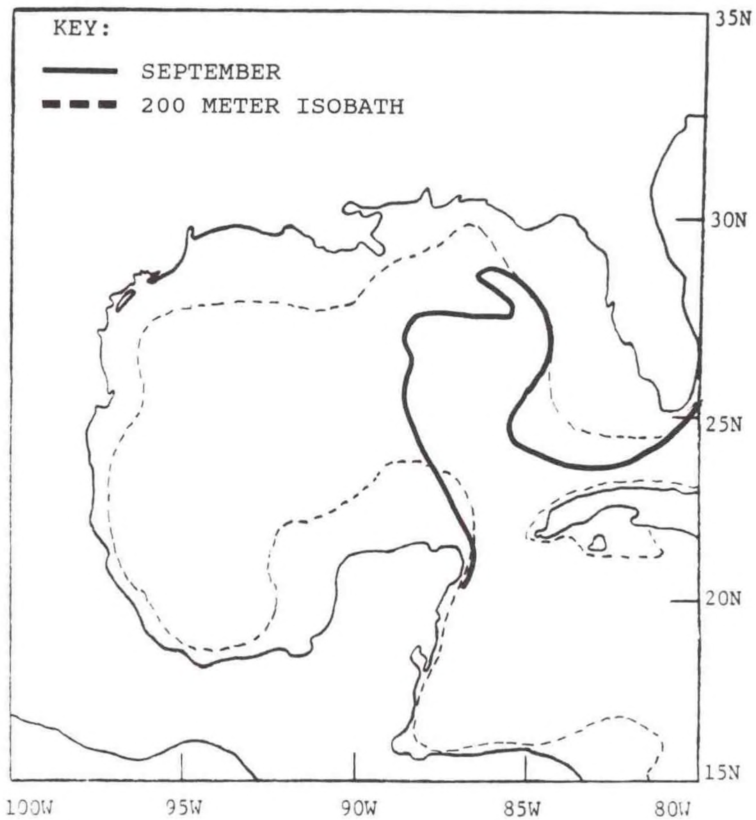

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in <u>Oceanographic Monthly Summary</u>: September, 1985.

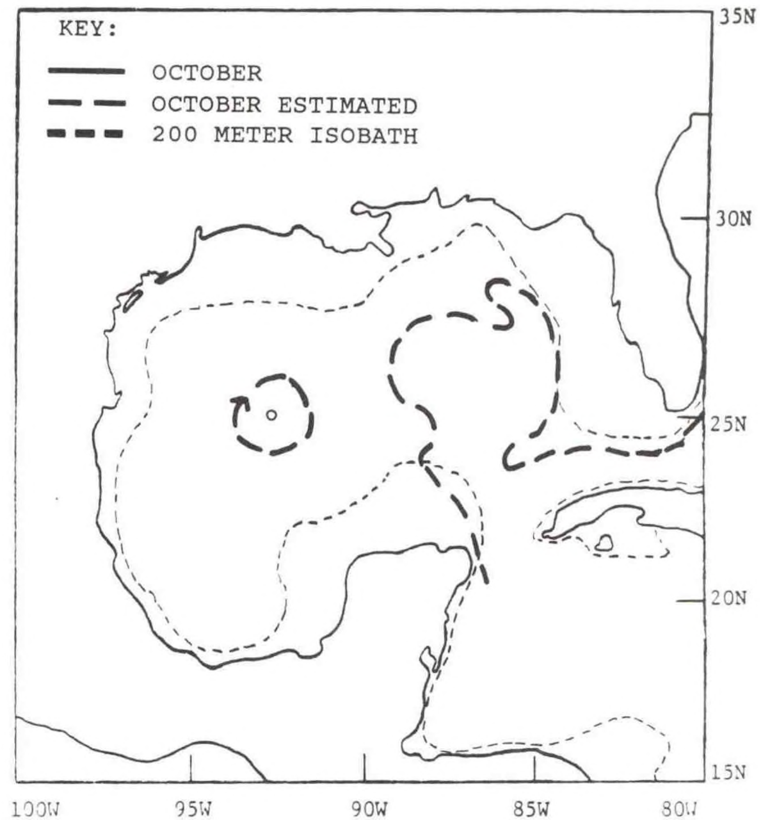

Figure 3-11.--Northern extent of the Loop Current. Figure drawn from material in <u>Oceanographic Monthly Summary</u>: October, 1985.

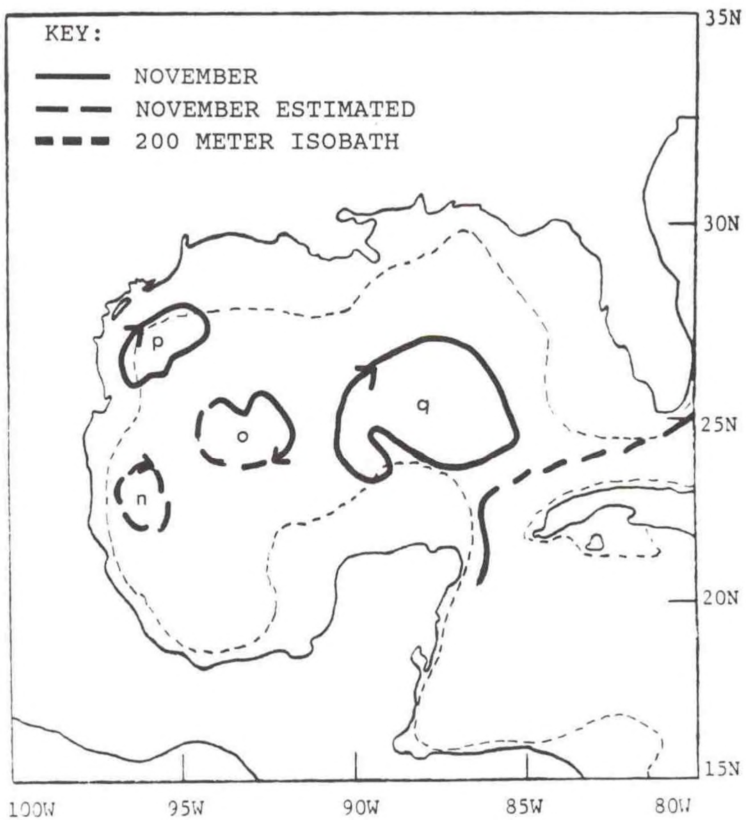

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: November, 1985.

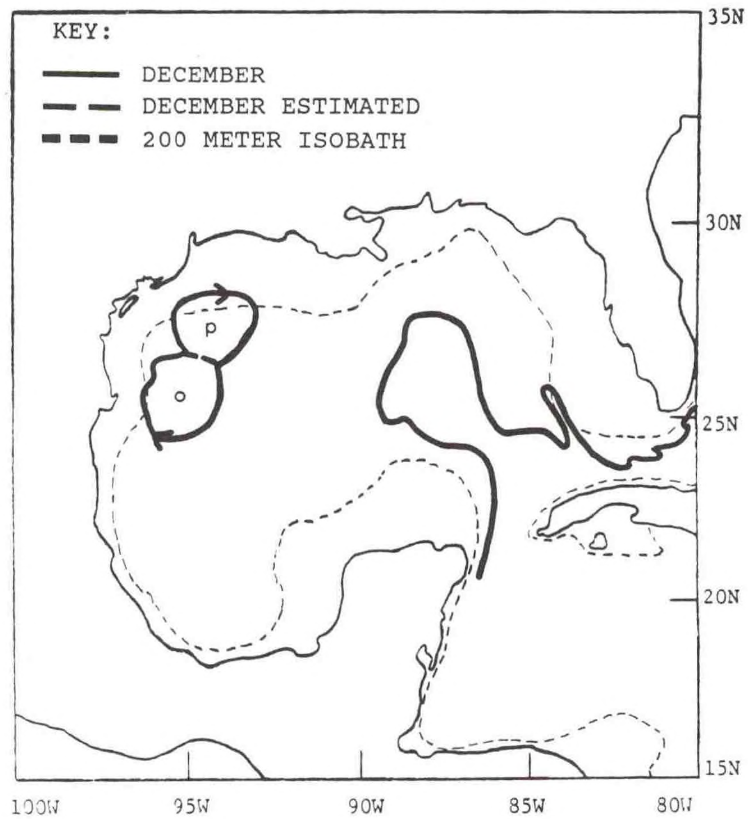

Figure 3-11 (Continued).--Northern extent of the Loop Current. Figure drawn from material in Oceanographic Monthly Summary: December, 1985.

significant changes in the circulation pattern for the water column. Impacts to the shelf (coastal) fisheries would thus depend on which fishery requires these shelf waters for spawning during the spring.

The Loop Current appears to follow a cyclic pattern. This pattern can be idealized as an intrusion of warm water into the Gulf that extends to some maximum northern limit. Then an anticyclonic eddy or (eddies) is spun off. The eddy (eddies) can move slowly in a westerly to southwesterly direction into the western Gulf or be reabsorbed into the Loop Current only to be spun off again later. After the eddy is spun off, the Loop Current retreats to its southern limit (minimum intrusion into the Gulf), which can be as far south as Cuba. This idealized cycle can have a repeat period from less than one year to almost two years.

The cyclic pattern of maximum intrusion of the Loop Current and the eddies and filaments that are produced by this current dominate the circulation in the eastern Gulf of Mexico and the Florida shelf. The eddy, which becomes detached from the Loop Current, slowly migrates westward, affecting the circulation and water mass properties within the western Gulf. Its ultimate fate is unknown and under investigation. One hypothesis is that the eddy continues its westward movement and bounces off the Mexican coast, where it slowly decays. Two other eddy-like features are observed in the western Gulf. An anticyclonic eddy-like feature south of Galveston, TX, and a cyclonic feature in Campeche Bay have been observed.

In January 1985 the maximum northern limit of the Loop Current increased 90 kilometers from its December 1984 location. The northern limit of the Loop Current was not smooth, but consisted of several protrusion/filamentous-type structures. Several filaments, observed along the eastern side of the Loop Current extended northward almost to the 200 meter isobath of the Florida shelf. A large bulge of Loop Current waters was located over the Yucatan shelf to the north of an area where upwelling of cooler waters has been recorded in the literature.

In February the northern extent of the Loop Current increased approximately 100 kilometers, and the number of filaments increased. Along the Florida shelf intrusions inside the 200 meter isobath occurred off the Keys, and several small filaments and the Loop Current northern limit approached the Florida 200 meter isobath. Three southward-oriented filaments along the western side of the Loop Current were also observed with the southernmost one over the Yucatan shelf. An anticyclonic eddy designated "m" was observed off the Mississippi Delta region and was separated from the Loop Current by approximately 50 kilometers.

The Loop Current and eddy "m" began interacting during March, as a filament extended from the northwestern portion of the Loop Current towards the eddy. Eddy "m" moved 110 kilometers eastward during March. The filamentous structure of the Loop Current remained complex with several filaments/protrusions along its eastern side probably interacting with the waters of the Florida shelf. The Yucatan shelf had several smaller filaments near the 200 meter isobath. A warm feature seen in February in the western Gulf was upgraded to the status of an eddy and labeled "n." Eddy "n" moved 55 kilometers northward to the region off the Texas/Mexican border.

The eastern Gulf of Mexico was filled with a complex filamentous-shaped Loop Current in April 1985. Eddy "m" was probably reabsorbed, thus the Loop Current extended northward onto the Louisiana and Florida shelves and westward to approximately 92° W. Four separate filaments of the Loop Current interacted with the shelf waters of Florida, while the waters of the entire Mississippi Delta region interacted with the northern limit of the Loop Current. The Yucatan shelf had two protrusions within its 200 meter isobath, while a strong offshore flow might have resulted from the eastern meandering flow of the current. A pinching off of the northern portion of the Loop Current along a diagonal from the Yucatan Peninsula to the Tampa Bay region of Florida occurred as filaments from these two areas combined. Eddy "n" in the western Gulf moved about 200 kilometers northward to the 200 meter isobath off Brownsville, TX.

Seasonal heating of the sea surface and increased seasonal cloudiness makes the detection of the Loop Current difficult during the summer. The May data showed a smoother, less complex shape for the Loop Current with its northern extent off the Mississippi/Florida panhandle and outside the 200 meter isobath. The Loop Current extended onto the south Florida shelf west of 83° W. The western portion of the Loop Current was not clearly defined at this time and eddy "n" was not detected.

The June data were from the first week of the month and showed a reduction in the northern limit of the Loop Current. A warm feature or westward expansion of the Loop Current was also depicted in the early June data. The Loop Current off the Florida shelf had moved southward to 27° N, a reduction of 2° of latitude from the previous month, while extending farther onto the shelf. There probably was some interaction between the warm feature/Loop Current and the Louisiana shelf waters around 91° W.

For the remainder of June through the end of September delineation of the Loop Current through the use of sea surface temperature was not possible due to the isothermal structure of the Gulf of Mexico. However, in mid-August the western portion of the Loop Current was partially discerned using the sun glint pattern in the visible band of the satellite data. A smooth curve, which extended slightly onto the Yucatan Peninsula and began to recurve westward at 27° N, was depicted in the NOAA data.

Due to the changing seasons and the increase in thermal contrast within the Gulf of Mexico, the Loop Current was depicted in thermal imagery during the last week of September. The Loop Current resembled a loop this month, except for a filament extending northwestward along the Florida shelf's 200 meter isobath. An extended region, almost 3° of latitude, of interaction of the Loop Current and the Florida shelf waters was probable along the eastern portion of the Loop Current. The Loop Current also extended along and onto the full length of the eastern portion of the Yucatan shelf.

Little change was detected in the Loop Current's northern limit between September and October 1985. The eastern boundary of the Loop Current was close to the Florida shelf's 200 meter isobath from approximately 25.5° to 28.5° N. The location of the Loop Current over the Yucatan shelf extended slightly westward compared to the September data. An eddy designated "o" was observed at 25° N 93° W and probably translated 175 kilometers west-southwest since late August, when it was detected in the ARGOS data.

The Loop Current shed an anticyclonic eddy designated "q" in November resulting in a dramatic reduction in the northern limit of the Loop Current to 24° N, a distance of 455 kilometers compared to the October data. Eddy "q" was located north of Yucatan and interacted with the shelf waters along the eddy's southern edge. Eddy "o" moved west-southwestward 75 kilometers in November. Two additional eddies were also detected in the western Gulf: eddy "r" was offshore Tampico, MX, and an elongated eddy "p" was oriented along the 200 meter isobath off Corpus Christi, TX. Eddy "p" probably affected the Texas shelf waters by bringing warmer, more saline waters onshore, while advecting cooler waters into the deeper Gulf waters.

Eddy "q" was reabsorbed into the Loop Current at the beginning of December resulting in an increase of the northern limit of the Loop Current of 520 kilometers to about 28° N. A long filament was located just offshore the 200 meter isobath of the south Florida shelf resulting in some Shelf-Loop Current mixing processes. Eddy "r" was not observed this month. Eddy "o" moved 195 kilometers northwestward and possibly interacted with eddy "p," which moved 90 kilometers east-southeastward. The shape of eddy "p" became more circular, but its northern edge remained along the Texas 200 meter isobath, as did the western edge of eddy "o".

SECTION 4

FISHERIES

In 1985 the Gulf of Mexico yielded the nation's largest regional commercial fishery by weight for the third consecutive year. The Gulf fisheries landings were 39 percent of the national total by weight and 28 percent by value. Fishermen harvested more than 2.4 billion pounds of finfish and shellfish worth over $590 million (Table 4-1). These landings were less than 1984's catch by 200 million pounds valued at $65 million. Louisiana and Mississippi landings were ranked first and fourth, respectively, in the nation by weight. The Louisiana catch was valued at $229.1, third in the United States. The state landings of Texas and Florida followed in fourth and fifth places in value nationally.

4.1 Summary of Commercial Fishing

Combined shellfish and finfish landings in the Gulf of Mexico exceeded 2.4 billion pounds and were worth $590 million (Table 4-1). The major components of the Gulf fishery are shrimp, oysters, blue crabs, and menhaden. The 1985 harvests of shrimp and oysters increased in weight and value from 1984, while the landings of blue crabs and menhaden decreased in both weight and value. The decline in the menhaden catch followed the projection by National Marine Fisheries Service scientists that the stock would not sustain the record yields of the previous three years. However, the catch was nearly 2 billion pounds and enabled Louisiana and Mississippi to dominate the combined regional fishery landing weights (Figure 4-1). The low commercial value of menhaden ($0.04/pound) resulted in a more uniform market distribution of the landings by value among the states (Figure 4-2).

4.2 Finfish

Total finfish landings (Table 4-1) were nearly 2.1 billion pounds valued at $128 million. These were decreases of 10 percent in both weight and value from 1984. Based on the total finfish catch by weight the Gulf region rankings were as follow: Louisiana, Mississippi, Florida (west coast), Alabama, and Texas. Excluding menhaden, the rankings change dramatically. Florida becomes the leader, while Louisiana falls to a distant third. Based on the value of the total finfish landings the states are ranked in this order: Louisiana, Florida, Mississippi, Texas, and Alabama (Figure 4-3).

Menhaden, which is used primarily in the production of meal and oils, is the dominant fishery by weight in the Gulf of Mexico, contributing 94 percent of the total Gulf landings in 1985. Menhaden landings decreased nationally by 5 percent in 1985. The decline can be attributed to the 10 percent decrease in the Gulf menhaden landings. National Marine Fisheries Service

Table 4-1.--Commercial landings of finfish and shellfish, by state in 1985 for the Gulf of Mexico.

State	Finfish (pounds x 10^3)	Shellfish (pounds x 10^3)	Total Weight (pounds x 10^3)	Total Value ($ x 10^3)
Texas	3,782	97,694	101,476	174,300
Louisiana	1,540,981	151,810	1,692,791	224,699
Mississippi	451,266	19,382	470,648	40,136
Alabama	6,021	23,538	29,559	40,664
Florida (west coast)	64,950	51,846	116,796	114,160
Total	2,067,000	344,270	2,411,270	593,959

All data are preliminary from the National Marine Fisheries Service. Catch from high seas or off foreign shores is not included.

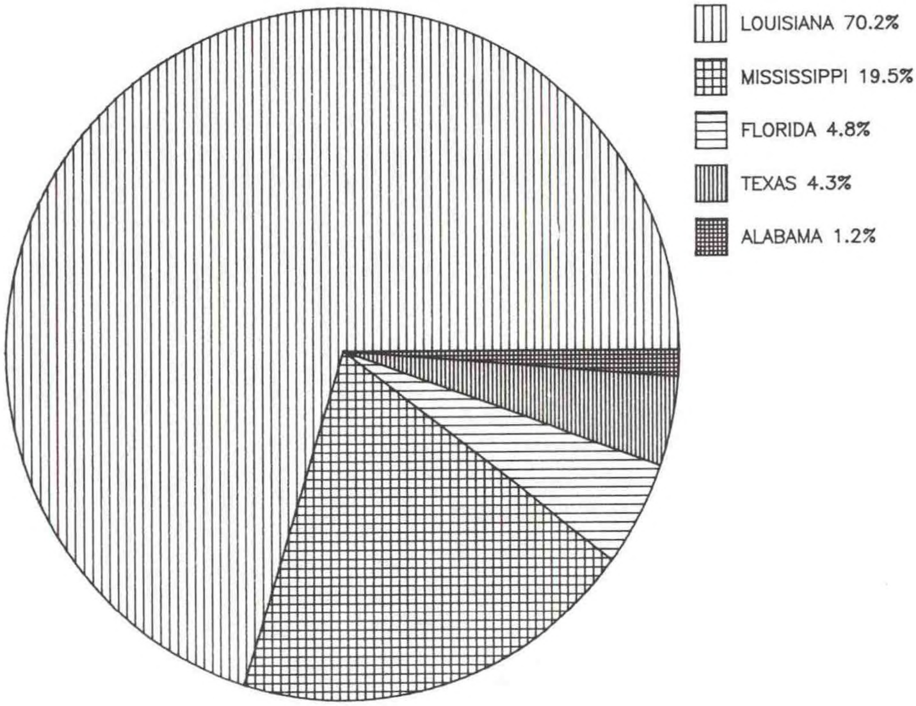

Figure 4-1.--Gulf of Mexico 1985 total finfish and shellfish landings: percent of weight by state.

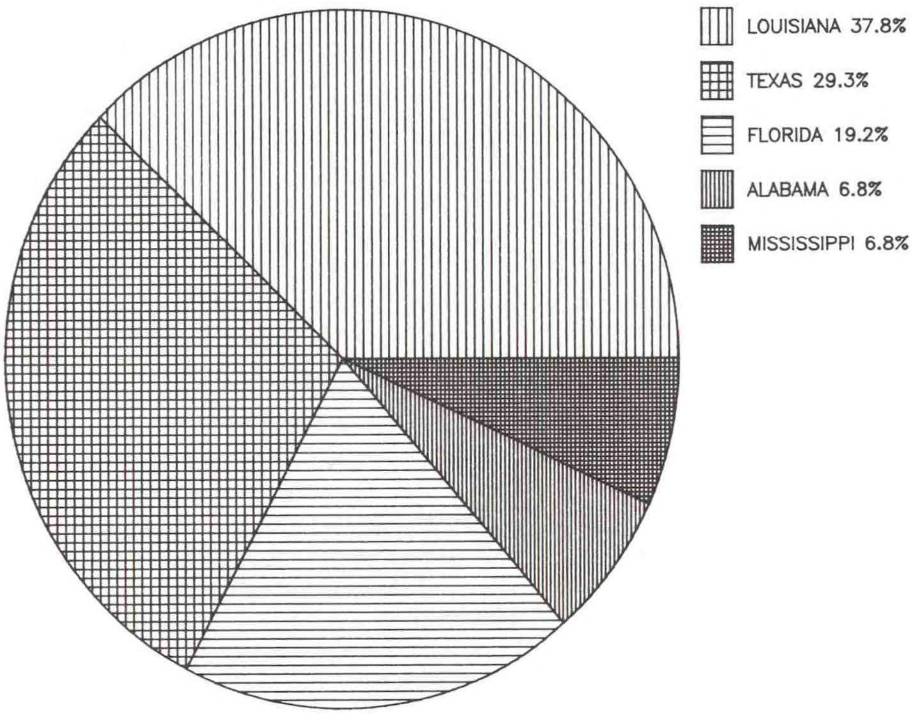

Figure 4-2.--Gulf of Mexico 1985 total finfish and shellfish value: percent of total dollar value by state.

scientists had forecast that the menhaden stocks could not sustain the record harvests of recent years.

Other leading fisheries in the Gulf of Mexico are mullet, grouper, and snapper (Table 4-2). Excluding the menhaden landings, finfish landings decreased by more than 13 million pounds in 1985. However, the value of these landings increased $3.5 million.

4.3 Shellfish

The Gulf of Mexico shellfish fishery is dominated by three shrimp species: the brown, white, and pink shrimp. These three species are aggregated in the landings data (Table 4-3). Other important species in the Gulf shellfish fishery are blue crabs and oysters. Florida has major spiny lobster and stone crab fisheries.

Texas, with 36.7 percent, and Louisiana, with 34.1 percent, led the Gulf in dollar value of shellfish landings in 1985 (Figure 4-4). These percentages were bolstered by large shrimp catches in both states. Shellfish landings were 344.3 million pounds valued at $465.4 million in 1985 (Table 4-3). These figures represent no change in weight and a 9 percent decrease in value from 1984.

The shrimp fishery continued to recover after consecutive years of declining landings in 1982 and 1983. Shrimp landings rose from 254.2 million pounds in 1984 to 261.7 million pounds in 1985. However, the value of these landings was $395.8 million, a decrease of $43.9 million from 1984. This decrease in value of the crop was a result of a general lower price per pound paid around the Gulf and a decrease of 7 million pounds in the Texas catch, which typically exacts the highest price per pound for shrimp.

The decrease in the Texas landings might be the result of several environmental events. The tropical storm and four hurricanes that hit the Gulf in 1985 reduced the fishing time. The mass transport was strong onshore in February, but was strong longshore in March. These are the months that the larvae are blown into the estuaries, and the reduced onshore transport in March probably limited the number of larvae that entered the estuaries. Above-normal March streamflow might have washed the juvenile shrimp from the estuaries before they were ready to move offshore, or the flow altered the temperature and salinity regimes, and the shrimp followed these patterns. The thought that the shrimp left the estuaries early is supported by the fact that the size of the shrimp harvested in early catches was uncharacteristically small. Nevertheless, Louisiana led the nation in shrimp landings with 34 percent of the total United States catch. Texas followed closely with 25 percent of the total landings.

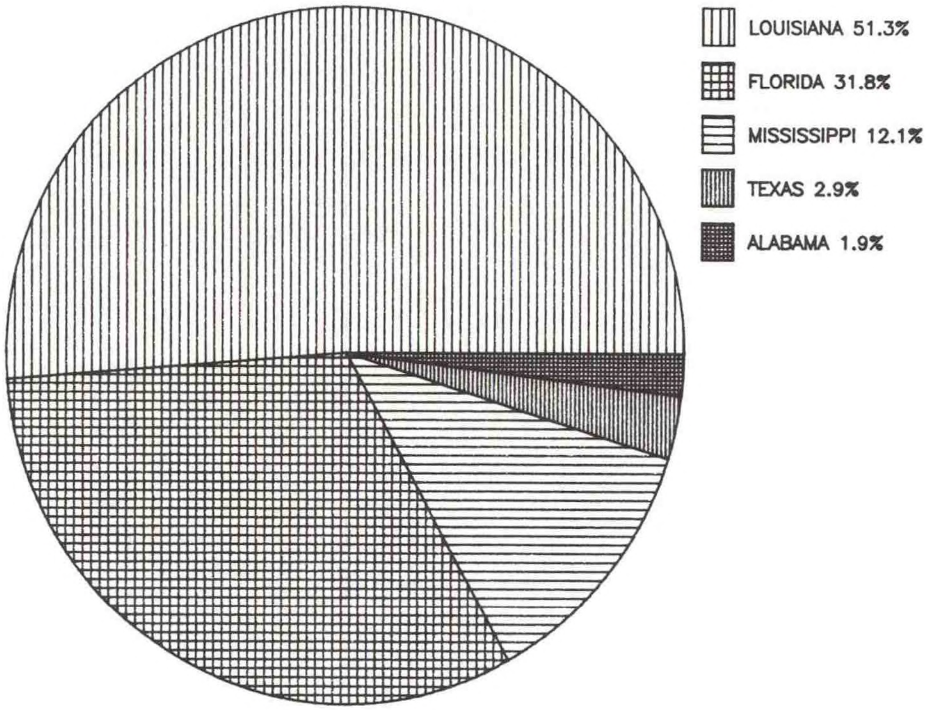

Figure 4-3.--Gulf of Mexico 1985 total finfish value: percent of total dollar value by state.

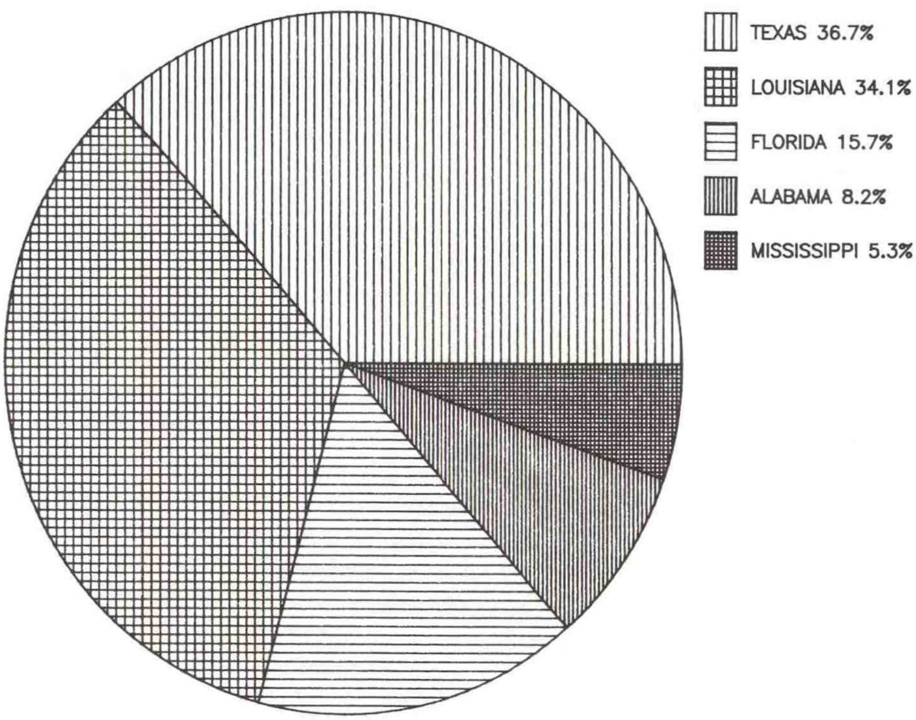

Figure 4-4.--Gulf of Mexico 1985 total shellfish value: percent of total dollar value by state.

Table 4-2.--Total finfish landings by species for the Gulf of Mexico region, 1985.

Species	Distance from U.S. Shores: From 0 to 3 miles, Thousand Pounds	From 0 to 3 miles, Thousand Dollars	Between 3 and 200 miles, Thousand Pounds	Between 3 and 200 miles, Thousand Dollars	Total, Thousand Pounds	Total, Thousand Dollars
Alewives	110	8	0	0	110	8
Bluefish	486	97	2	(1)	488	97
Bonito	0	0	54	6	54	6
Croaker	261	120	58	29	319	149
Flounder:						
Fluke	175	135	0	0	175	135
Atlantic/Gulf	953	803	334	191	1,287	994
Grouper	209	314	10,156	15,047	10,365	15,361
Mackerel:						
King/Cero	51	47	1,654	1,407	1,705	1,454
Spanish	571	146	2,127	688	2,698	834
Menhaden	1,787,024	63,078	160,801	4,375	1,947,825	67,453
Mullet	17,988	4,990	11	3	17,999	4,993
Scup or Porgy	80	48	208	124	288	172
Sea Bass, Black	17	7	0	0	17	7
Sea Trout:						
Spot	1,972	2,063	1	1	1,973	2,064
White	395	217	202	68	597	285
Sharks	47	19	692	281	739	300
Snapper:						
Red	47	31	4,207	8,484	4,254	8,515
Other	415	614	2,004	2,957	2,419	3,571
Swordfish	0	0	1,080	3,000	1,080	3,000
Tilefish	0	0	330	290	330	290
Tuna:						
Bigeye	0	0	26	66	26	66
Blackfin	0	0	24	6	24	6
Bluefin	0	0	147	418	147	418
Little	6	1	7	1	13	2
Yellowfin	0	0	3,140	3,732	3,140	3,732
Unclassified	0	0	86	109	86	109
Fish, Other	40,666	9,547	27,790	4,472	68,456	14,019
Total Finfish	1,851,473	82,285	215,141	45,755	2,066,614	128,040

All data are preliminary from the National Marine Fisheries Service.
Catch from high seas or off foreign shores is not included.

(1) Less than $500.

Table 4-3.--Total shellfish landings for the Gulf of Mexico region, 1985.

Species	Distance from U.S. Shores: From 0 to 3 miles, Thousand Pounds	From 0 to 3 miles, Thousand Dollars	Between 3 and 200 miles, Thousand Pounds	Between 3 and 200 miles, Thousand Dollars	Total, Thousand Pounds	Total, Thousand Dollars
Shrimp	137,243	142,871	124,450	252,976	261,693	395,847
Oyster Meat	25,447	38,777	0	0	25,447	38,777
Crabs, Blue	49,378	14,315	0	0	49,378	14,315
Lobster, spiny	700	1,680	2,688	6,485	3,388	8,165
Crab, Other	526	885	3,332	6,531	3,858	7,416
Shellfish, Other	129	293	202	423	331	716
Clams, Hard	68	130	0	0	68	130
Squid	36	14	71	19	107	33
Total	213,527	198,965	130,743	266,434	344,270	465,399

All data are preliminary from the National Marine Fisheries Service.
Catch from high seas or off foreign shores is not included.

Hard blue crabs showed a decline in 1985 from record landings in 1984 in the United States. The Gulf of Mexico followed the trend with decreased landings of 1.6 million pounds and decreased value of $700,000. Louisiana accounted for about one-half of the 49 million pounds of blue crabs landed in the Gulf in 1985.

Although national oyster landings declined for the second consecutive year, oyster landings in the Gulf increased by 1 million pounds to 25.4 million pounds valued at $38.8 million. This represented an increase of $2.8 million from 1984. The region led the nation with 58 percent of the total United States landings. Louisiana led the region with 53 percent of the landings. Texas landings were 20 percent of the regional total.

SECTION 5

RECREATION

The Gulf of Mexico is a major recreational area of the United States, particularly for boating, saltwater fishing (bay, surf, and pier), and beach activities. The coasts of Texas, Louisiana, Mississippi, Alabama, and Florida display a diversity of natural landscapes. Barrier islands, coastal beaches, bays, sounds, river deltas, and marshes, together with a subtropical climate, provide an ideal setting for outdoor recreation and tourism. Tourism within the Gulf region encompasses such activities as sightseeing, swimming, sunbathing, bird watching, hiking, boating, amusement parks, conventions, sports, and festivals. Each of the Gulf states benefits recreationally from its Gulf coast, but the states of Louisiana, Texas, and Florida, with longer Gulf coastlines, derive larger benefits than the other two states. Florida, with its combination of Atlantic and Gulf beaches and its warm climate in the central and southern portions of the state, derives the most recreational benefit.

The recreational activities that take place around the Gulf of Mexico as a result of its marine environment have vital impacts on the economies of the states and the region. In Florida, tourism is the leading industry, contributing in 1985 about 18.8 percent of the total state tax collection. About 30 million domestic and Canadian visitors arrived by air or car in Florida in 1985.

In Figure 5-1 we have identified several leading indicators of recreational activity in the Gulf in 1984 and 1985. Overall, recreation was up slightly in 1985 in the Gulf region. In this assessment section, we have expanded these indicators to evaluate the impacts of recreation on the economies of Gulf states. National and state park visits, boating registrations, search and rescue operations, recreational fishing participation, fish catch, wildlife refuge visits, and hunting license/stamp purchases are among the major indicators of these impacts.

Although the exact relationship between the weather and the economy associated with recreation is not clear, prolonged periods of inclement weather (i.e., rain and cold) and episodes of severe weather (tornadoes, hurricanes, etc.) will impact the regional economy. On the whole, weather in 1985 in the Gulf did not affect overall recreational usage as the positive effects induced by warm, dry weather were balanced by the negative effects caused by cool, rainy weather over the year. The major weather impact on recreation came from the number of tropical cyclones striking the region during the fall. Of these, Hurricane Juan, which affected Louisiana in particular for an extended period in late October, was the most significant.

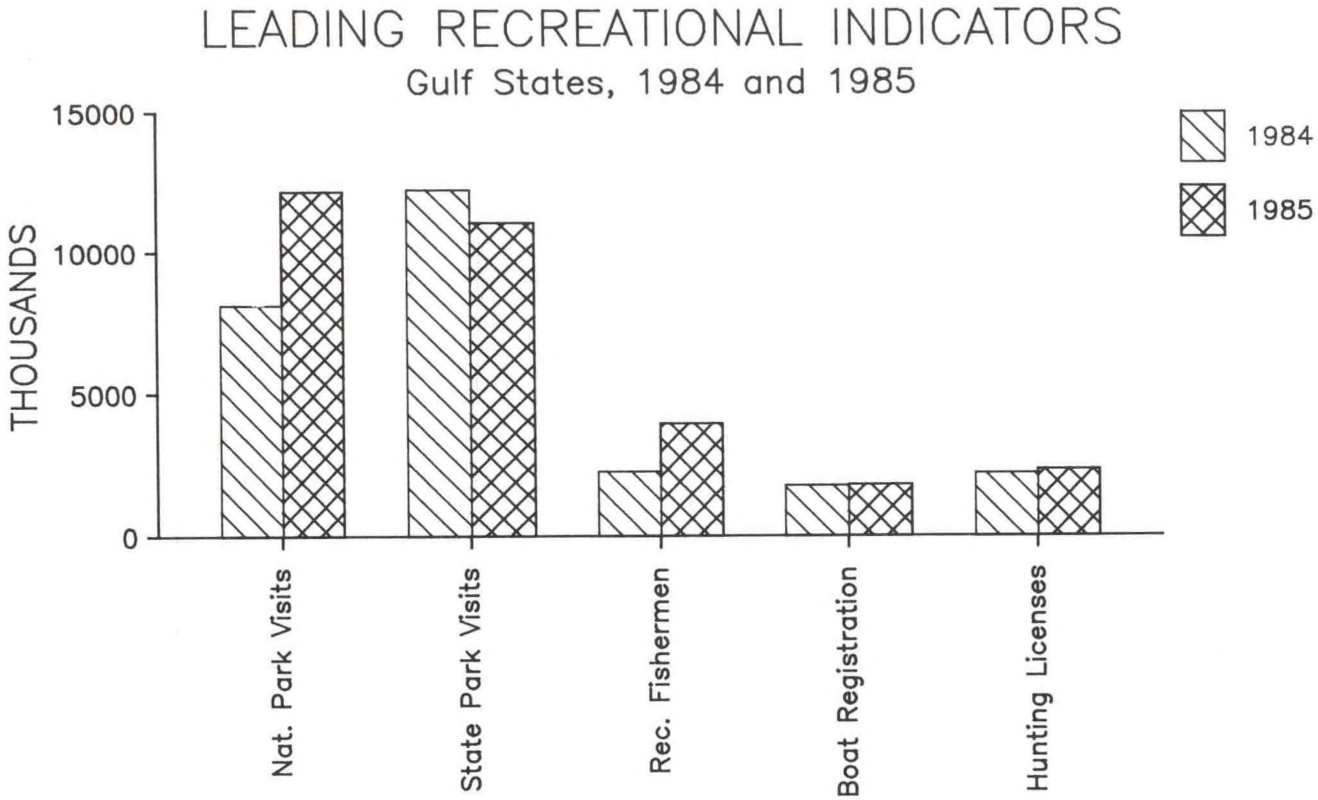

Figure 5-1.--Leading indicators of recreational activity, Gulf states, 1984 and 1985. Data from National Park Service; Alabama, Florida, Louisiana, Mississippi, and Texas parks departments; National Marine Fisheries Service, NOAA; U.S. Coast Guard; U.S. Fish and Wildlife Service.

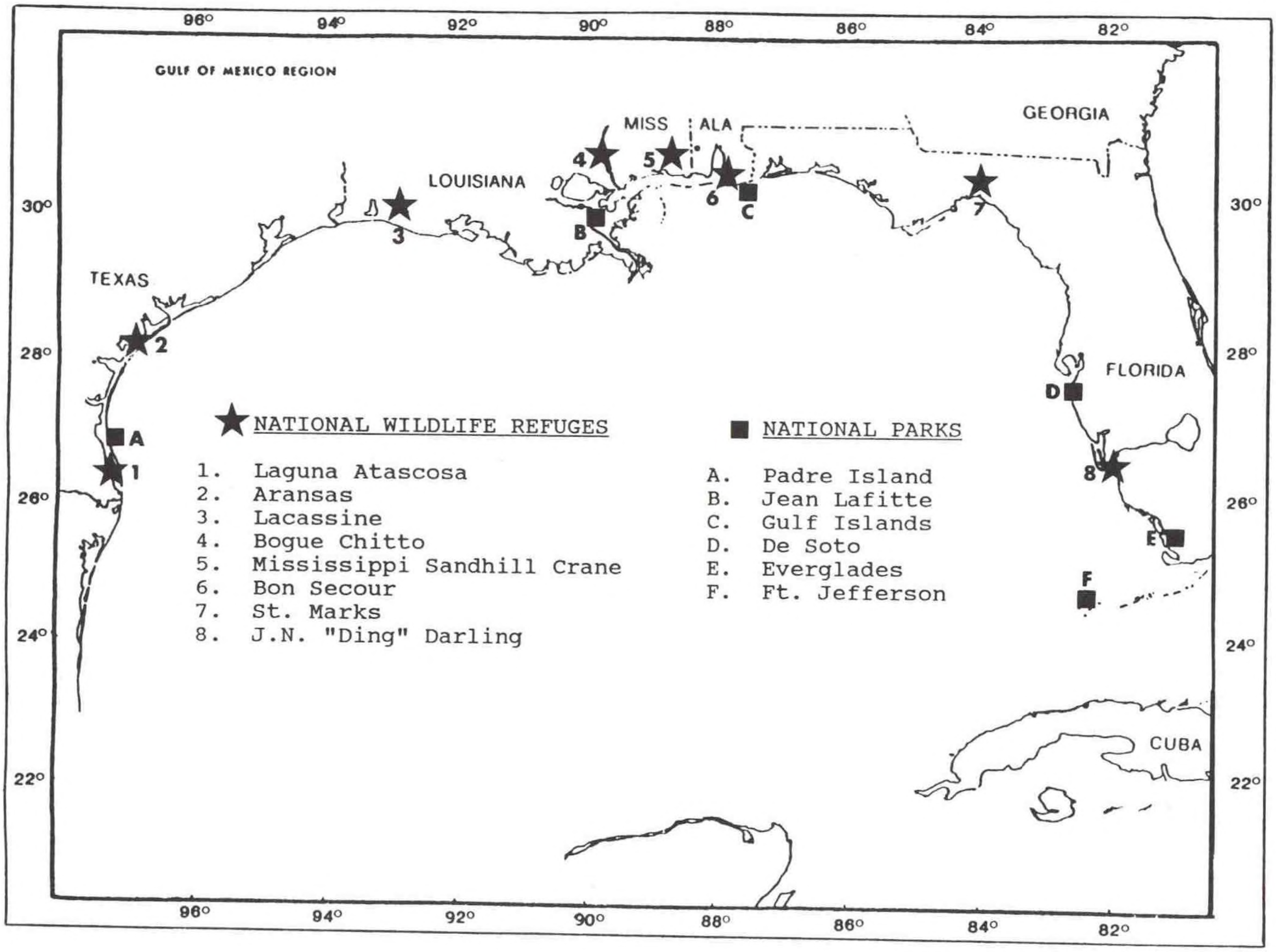

Figure 5-2.--Locations of selected national parks and wildlife refuges in the Gulf of Mexico.

A major recreational issue that arose in the Gulf region in 1985 was the dismantling of out-of-service oil rigs. These structures have a direct bearing on recreational fisheries as they serve as artificial reefs and are among the favored fishing grounds of sport fishermen. A full discussion of this issue is found in Section 7.

5.1 National Park Visits

The National Park Service of the Department of the Interior manages a number of national parks, national historical parks, national monuments, and national seashores in the states surrounding the Gulf of Mexico. Only those coastal sites for which data are available have been chosen for analysis. Four parks are located along the coast of Florida, and there is one park in each of the other Gulf states, except Alabama. Figure 5-2 shows the locations of national parks discussed in this section and the national wildlife refuges discussed in Section 5.6.

The attendance in 1985 at Gulf site national parks increased overall by about 50 percent from 1984 (Table 5-1). In Florida, De Soto National Memorial Park experienced a small decline from 1984, but the attendance increase at Gulf Islands National Seashore in both Florida and Mississippi was a substantial 70 percent. Good weather and the increasing popularity of this area, particularly for Gulf state residents and those from neighboring states, were the major causes of the upwswing. The May increase in attendance at both parts of the seashore park was 136 percent. Jean Lafitte National Historic Park experienced an attendance decline of approximately 16 percent in 1985 over 1984 visits. However, this decline was not as large as might be expected, since 1984 attendance had been inflated by visits generated by the World's Fair in New Orleans. Camping and other facilities which had been added to the park just prior to the Fair proved to be a continuing attraction to travelers in 1985. The 1985 attendance figure was well above the one for 1983 by 34 percent. Padre Island National Seashore, which had been showing declines over the past few years, recorded a 9 percent increase in visits. Dry and warm weather in July and August helped to increase number of visits in these two months compared to 1984 by 11 and 38 percent, respectively.

The national parks in the Gulf region have individual monthly attendance patterns which are usually dependent on temperature or season, but which may be altered due to unseasonable weather or special events (Figures 5-3a and 5-3b). In 1985, these visits appeared to follow normal patterns. Parks located in or near southern and central Florida tourist areas visited in the late winter and early spring had highest attendance in the months from December through April. Gulf Islands National Seashore, located in the northwestern Florida,

Table 5-1.--National park visits (in thousands) to Gulf sites, 1983-1985.

	1983	1984	1985
FLORIDA			
De Soto National Memorial	221	222	202
Everglades National Park	577	629	698
Fort Jefferson National Monument	11	12	13
Gulf Islands National Seashore	3,248	4,643	7,905
Total (Florida Gulf	4,057	5,506	8,818
LOUISIANA			
Jean Lafitte National Historic Park and Preserve	535	849	714
MISSISSIPPI			
Gulf Islands National Seashore	812	1,161	1,976
TEXAS			
Padre Island National Seashore	630	613	669
TOTAL (all Gulf sites)	6,034	8,129	12,177

Data from National Park Service, Denver Service Center, Statistics Office.

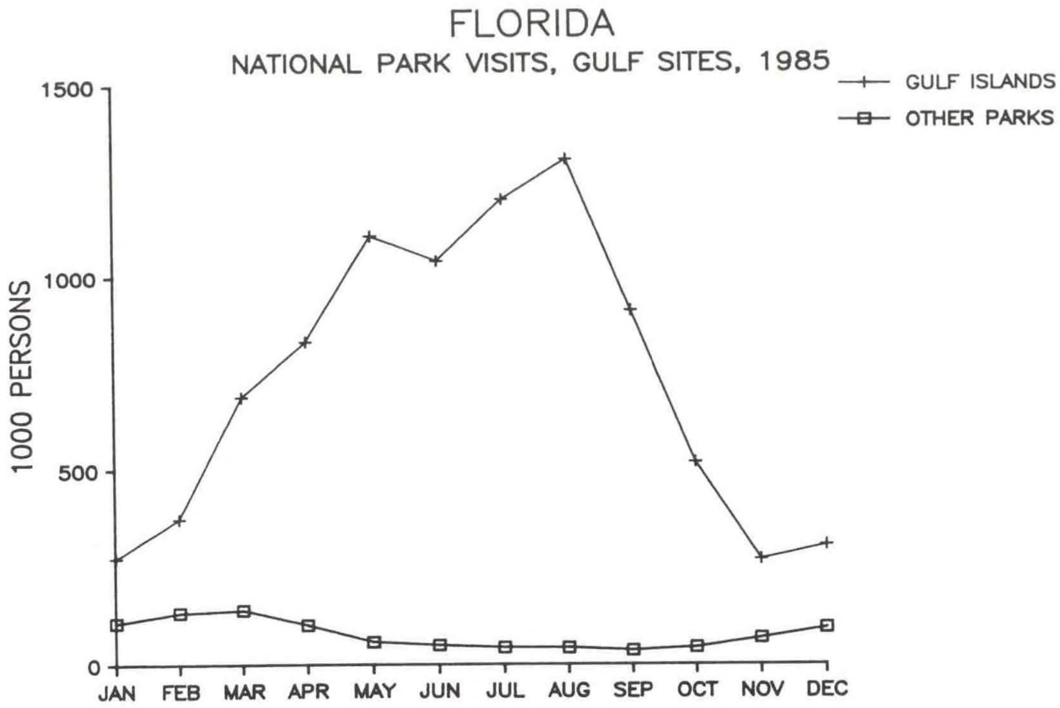

Figure 5-3a.--Monthly visits to Florida Gulf site national parks, 1985. Data from National Park Service, Denver Service Center, Statistics Office.

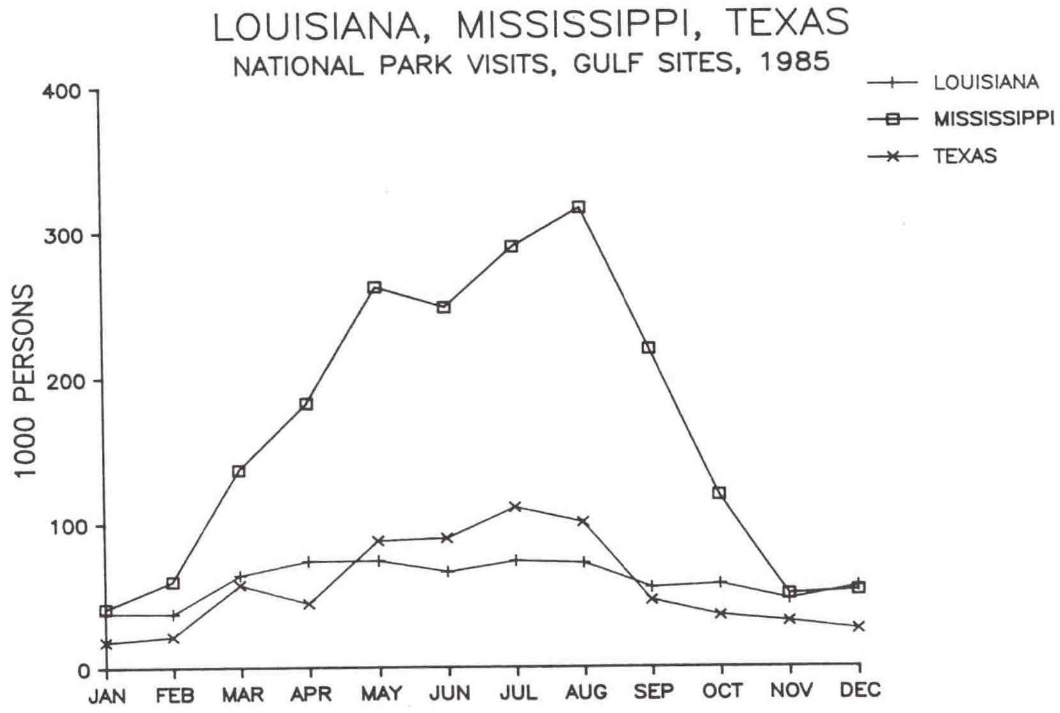

Figure 5-3b.--Monthly visits to Louisiana, Mississippi, and Texas Gulf site national parks, 1985. Data from National Park Service, Denver Service Center, Statistics Office.

displayed a different pattern (Figure 5-3a). In this part of the seashore park as well as in the Mississippi section (Figure 5-3b), temperatures are warm enough for beach activities much of the year, but the cool temperatures that prevail in December, January, and February keep attendance down in these months. Beginning in March 1985 attendance rose and peaked in August. High visitation at Jean Lafitte coincided with late spring and summer weather from April through August (Figure 5-3b). Padre Island National Seashore, which has a substantial tourist attendance and also attracts local residents to its beaches, had its highest attendance during the summer months of June, July, and August (Figure 5-3b).

5.2 State Park Visits

State park visits around the Gulf exhibited a more varied trend than those of the national parks due both to local weather conditions and to other local factors like changing user preferences. State park visits cannot be compared from state to state in the Gulf, because the methods of tabulating visits vary. Some states use their own fiscal year; others use a standard calendar year. While the trend in Gulf state park visits in 1985 was down from 1984, this tendency was not uniform. For example, most Florida Gulf park sites had attendance increases, but the state total for the year declined 28 percent to 2.4 million (Table 5-2). This was due almost wholly to a decrease in the attendance at Honeymoon Island, which was opened in 1983. Attendance in 1983 at this park was about 2.25 million, but only about 740,000 in 1985. This drop in attendance figures was largely due to changing methods of visitor counts. In 1983 and 1984 these counts were estimates; in 1985 they were actual counts. Alabama's only Gulf park had a modest decline in attendance in 1985 (Table 5-2).

In Mississippi, the pattern of variation continued. Gulf Marine Park had a modest decline in visits of about 4 percent (Table 5-2). However, Buccaneer State Park, which has camping facilities that were enhanced to accommodate travelers to the 1984 New Orleans World's Fair, had increases in attendance from 1984. Visits at Buccaneer rose about 8 percent in 1985. Like Jean Lafitte National Historic Park, parks in the New Orleans area with camping facilities continued to attract overnight visitors.

Since Louisiana's method of collecting park statistics was changed in 1985, data cannot be directly compared with those from previous years. The basic change involved employing user counts based on entrance fees in place of the former system which automatically counted the axles of vehicles entering state parks. To avoid confusion, Louisiana park attendance figures are not presented in our study. However, according to a Louisiana park official, there was an increase in state park attendance in 1985 of about 2 percent.

Table 5-2.--State park visits, Gulf Coast, in thousands, 1983-1985.

	1983	1984	1985
ALABAMA			
Gulf State Park	1,798.0	2,281.0	2,036.0
FLORIDA			
Big Lagoon	67.3	86.9	77.9
Calodesi Island	125.3	125.2	149.7
Grayton Beach	43.3	49.5	53.5
Honeymoon Island	2,225.0	1,767.8	739.6
Rocky Bayou	43.5	51.3	52.0
St. Andrews	550.5	569.5	576.4
St. George Island	91.2	107.6	123.9
St. Joseph Peninsula	99.8	94.6	101.8
Scherer, Oscar	100.2	99.2	100.8
Wiggins Pass	411.7	429.7	446.8
Total Florida Gulf parks	3,757.8	3,381.3	2,422.4
MISSISSIPPI			
Gulf Marine	170.1	167.6	160.3
Buccaneer	232.3	609.0	659.5
Total Mississippi Gulf Parks	402.4	776.6	819.8
TEXAS			
Bryan Beach	17.6	16.8	21.7
Copano Bay St. Park	37.8	27.4	23.7
Galveston Island	688.8	342.5	529.1
Goose Island	410.3	432.7	392.1
Matagorda Island	*	*	19.6
Mustang Island	1,068.3	1,247.6	935.8
Port Isabel	30.3	20.3	17.2
Port Lavaca Causeway	10.2	23.6	33.8
Queen Isabella Fish Pier	131.4	115.4	99.5
San Jacinto Battleground	1,321.3	1,355.4	1,512.1
Sea Rim/Sabine Pass Battleground	324.6	410.3	356.6
Total Texas Gulf parks	4,040.6	3,992.0	3,941.2

*No data available, as 1985 was the opening year.

Data from Alabama Department of Conservation, Parks Division; Florida Department of Natural Resources, Division of Recreation and Parks; Mississippi Department of Natural Resources; Texas Parks and Wildlife Department.

Texas had a modest decline in Gulf site park attendance (Table 5-2). However, Galveston Island, fully recovered from the adverse attendance impacts resulting from the Alvenus oil spill, (see Gulf of Mexico Annual Summary 1984, pages 62-68) experienced a 55 percent increase in visits (Table 5-2).

5.3 Boating Registrations

Boating is a significant area of recreation in the Gulf of Mexico and has large economic impacts. Broad coastal areas with many bays, bayous, inlets, and rivers provide ample opportunities to launch and use recreational boats. The purchase of the boat represents only the first stage of economic impacts. In addition to the initial investment in the boat itself, other expenditures are requried for berthing or trailering the boat and launching it. Considering the cost of fuel, boat repairs, maintenance, and expenditures for trips to use the boat, it is clear that boat ownership has impacts that multiply in the regional economy.

The total number of boats in the Gulf region registered under the approved Coast Guard numbering system rose by only 1.4 percent in 1985. This was slightly less than the national rate of boating growth of 1.7 percent. Nonetheless, considering declines in the oil industry in Louisiana and Texas, which affected the economies of these states, the boating growth in the Gulf should be considered an indicator of the vitality of the recreational economy. Florida experienced the largest growth in registrations reflecting the continuing expansion of population in that state (Table 5-3).

Table 5-3.--Boating registrations, in thousands, Gulf of Mexico states, 1983-1985.

	1983	1984	1985
Alabama	227.6	229.9	223.6
Florida	526.5	517.4	537.1
Louisiana	303.0	312.1	315.1
Mississippi	123.2	122.2	130.1
Texas	594.9	599.6	600.5
Total Gulf states boating registrations	1,775.2	1,781.2	1,806.4
Total U.S. boating registrations	9,165.1	9,420.0	9,583.7

Data from U.S. Coast Guard.

5.4 Search and Rescue Operations

The Search and Rescue (SAR) operations of the U.S. Coast Guard involve a number of incidents related to boating. Of the responses of the Coast Guard to recreational boat incidents, only about 4 percent are for fires and collisions. About 68 percent of the recreational cases nationwide involve boats which are disabled or adrift, and another 10 percent are for boats that ran aground. Increased recreational boating activity probably increases demand for SAR operations.

A comparison of the recreational SAR caseload during the first 9 months of 1985 with the caseload for the same period in 1984 shows that it increased in 5 of the 6 months of March through August, traditionally good boating months in the Gulf. In September, with the onset of tropical cyclone activity in the Gulf, the Coast Guard reported 88 fewer cases of recreational SAR than in 1984, probably indicating that fewer boats went out of port when this kind of weather was forecast (Table 5-4).

Table 5-4.--Recreational and total Search and Rescue caseload, U.S. Coast Guard, Gulf of Mexico, 1983-1985.

	1983	1984	1985
January	272	161	161
February	224	223	200
March	324	296	420
April	481	399	424
May	569	519	578
June	604	590	681
July	739	634	628
August	510	538	545
September	395	466	378
October	351	324	N/A
November	242	294	N/A
December	186	268	N/A
Total recreational caseload	4,897	4,712	4,926*
Total of all cases	7,900	7,615	7,696*

*Estimate based on reported caseload for January-September 1985.

Data from U.S. Coast Guard.

In 1985 the estimated total SAR caseload in the Gulf rose slightly after two years of decline.

5.5 Recreational Fishing in the Gulf

Recreational fishing is not only a sport that is personally gratifying to those who engage in it, it is also a sport which enriches local economies and the regional economy. Nationally, on the average, in 1980 saltwater fishermen fished for 12 days and spent an average of $16.00 per day. The simplest fishing activity requires a rod and bait. More skilled fishermen may spend large amount of money on gear, clothing, trips, and boats. Individual localities benefit from the large number of fishermen who travel to them to pursue the sport either individually or to attend fishing tournaments which abound in the Gulf region. These localities may be significantly affected when environmental events occur in such a way to curtail activities and even, in some cases, fisheries resources.

The National Marine Fisheries Service (NMFS) collects data on recreational fishing in the Gulf through intercept surveys and telephone surveys conducted in each state. NMFS statistics indicate the total estimated number of fish caught in the region increased in 1985 from the depressed level of 1984 and exceeded the 1983 level by 6 percent (Table 5-5). For the years 1982 to 1984 catch taken by Texas boaters was not included in the NMFS data because of reporting problems. The decline in estimated recreational catch between 1983 and 1984 has been attributed to various climatological events. Among these are the long-term impacts of a freeze which occurred in late December 1983 in the nearshore waters of Texas and Louisiana killing fish; and the large amount of freshwater runoff from Louisiana, which prevented estuarine species from finding their preferred salinities in nearshore waters in the spring of 1984 (see Gulf of Mexico Annual Summary 1984, page 71). NMFS data indicate an increase in recreational fishing levels in the Gulf in 1985. Estimated number of coastal and non-coastal participants in Gulf recreational fishing rose to almost 4 million in 1985, and the estimated number of fishing trips rose to 24.2 million (Table 5-6). The levels of estimated catch, participants, and trips taken compare favorably with those for 1980, the last year for which data without large statistical gaps are available. NMFS reports that participation in marine recreational fishing in the Gulf during 1985 was considerably higher than the 1979-84 mean of 2.9 million participants. Spotted seatrout and red drum were the most highly sought species in 1985, and saltwater catfishes and spotted seatrout were the most frequently caught fish.

5.6 Wildlife Observation and Hunting

The Gulf region provides many opportunities for both wildlife observation and for hunting. Coastal areas provide scenic vistas from which to view migratory waterfowl and birds,

Table 5-5.--Estimated number, in thousands, of fish caught in the Gulf of Mexico by marine recreational fishermen by species group, 1983-1985.

SPECIES GROUP	1983	1984	1985
Amberjack	281	117	230
Barracudas	138	171	108
Bass, Black Sea	1,096	516	5,784
Basses, Sea	2,326	1,722	3,621
Bluefish	1,529	432	937
Blue Runner	2,235	501	935
Catfishes, Freshwater	688	188	100
Catfishes, Saltwater	20,435	12,347	20,334
Croaker, Atlantic	11,559	7,978	12,264
Dolphins	213	361	609
Drum, Black	1,461	785	1,089
Drum, Red	4,677	3,816	4,110
Drums	1,875	2,735	2,052
Eels	156	269	124
Flounder, Gulf	358	783	502
Flounder, Southern	1,942	504	1,960
Flounders	2,095	483	424
Groupers	2,216	2,651	2,885
Grunt, White	2,782	3,575	3,973
Grunts	2,624	8,461	4,513
Herrings	8,205	2,924	7,727
Jack Crevalle	1,006	567	164
Jacks	1,804	1,693	1,373
Kingfishes	2,056	2,809	3,537
Little Tunny	439	151	287
Mackerel, King	248	283	235
Mackerel, Spanish	2,843	972	1,452
Mullets	3,307	4,993	7,162
Perch, Silver	962	634	1,734
Pigfish	1,174	1,157	1,312
Pinfish	11,481	8,480	9,374
Pompano, Florida	109	47	43
Porgies	1,742	951	334
Porgy, Red	119	106	1,110
Puffers	328	226	157
Searobins	125	39	46
Seatrout, Sand	4,973	6,311	9,509
Seatrout, Spotted	14,061	9,352	14,682
Sharks	308	454	833
Sheepshead	3,356	2,087	2,224
Skates and Rays	251	775	655
Snapper, Gray	2,959	3,012	1,657
Snapper, Lane	336	800	284
Snapper, Red	3,672	1,307	1,954
Snapper, Vermilion	250	420	462
Snapper, Yellowtail	930	2,119	535
Snappers	281	1,201	187
Spot	425	--	49
Toadfishes	186	89	138
Triggerfishes/Filefishes	794	367	339
Tunas/Mackerels	86	366	201
Other Fish	5,632	6,658	6,383
Totals	135,134	109,745	142,693

--Less than 30,000 reported.

Data from Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts; 1983-1984, 1985 (NOAA; National Marine Fisheries Service; 1985, 1986).

Table 5-6.--Summary of marine recreational fishery statistics, Gulf of Mexico, 1979-1985.

Year	Estimated number of fish caught (thousands)	Estimated number of participants (thousands)	Estimated number of fishing trips (thousands)
1979	162,279	3,460	21,273
1980	154,176	4,035	24,471
1981	131,407*	2,212*	19,089*
1982	154,405**	2,404	20,520
1983	135,134**	2,838	20,500
1984	109,745**	2,272	16,397
1985	142,693	3,959	24,227

*No survey conducted during January-February 1981.

**Does not include catch by Texas boat modes.

Data from Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979 (Revised)-1980; 1981-1982; 1983-1984; 1985 (NOAA; National Marine Fisheries Service; 1984, 1985, 1986).

small and big game, reptiles, and amphibians. In Federal wildlife refuges, the public has the opportunity to view endangered or threatened species that have been kept in these protected areas to promote their survival. Hunting opportunities for big game, small game, and migratory waterfowl exist on both public and private lands in coastal areas. Both wildlife observation and hunting, while providing recreational opportunities, also enrich the local economies. In any one year these activities can be strongly influenced by weather events since optimum bird-observing times and hunting seasons fall within a limited timeframe. Thus climate and weather are strong determinants of the value from this recreation. Since wildlife observation and hunting have different economic impacts and are sometimes affected differently by weather, they are considered separately.

5.6.1 Wildlife Observation

While the backyard observation and feeding of wildlife is enthusiastically enjoyed by millions of Americans, the taking of trips to observe wildlife has more significant economic impact. In 1980 over 29 million Americans (17 percent of the population 16 years and older) took at least one trip for the primary purpose of observing, photographing, or feeding wildlife. Of this number, 90 percent took at least one trip in their home state, 24 percent traveled to another state, and 4 percent visited another country. Total expenditures for these trips in 1980 were estimated by the U.S. Fish and Wildlife Service as $4 billion. Wildlife observers spend money for birdseed, film, film processing, binoculars, field guides, cameras, special clothing, courses in wildlife biology, and camping equipment for taking field trips.

Many wildlife observation visits go unrecorded as they take place in public areas where no counts are kept of this activity. However, a good indication of the degree of participation in wildlife observation is attendance at the national wildlife refuges maintained around the Gulf by the U.S. Fish and Wildlife Service. Some of these refuges are small and designed to support one species or one habitat. On the other hand, some refuges are large and support a variety of wildlife. Several of these refuges have been selected to illustrate this size variation and the magnitude of attendance at some of the larger refuges. These data for the years 1982-83 to 1984-85 are shown in Table 5-7, and their locations are shown in Figure 5-2. Since methods of counting visitors varies, it is not possible to draw inferences from the interannual changes in attendance figures.

5.6.1.1 Wildlife Observation of Endangered Species

The U.S. Fish and Wildlife Service maintains a list of endangered and threatened species. The wildlife refuge system has supported the resurgence of some of these species in protected habitats. An example of this is the Mississippi

Table 5-7.--Attendance at selected national wildlife refuges, Gulf States, 1983-1985.

REFUGE	1983	1984	1985
Aransas (TX)	93,170	61,102	63,830
Bogue Chitto (LA)	2,100	18,710	16,650
Bon Secour (AL)	N/A	915	N/A
J. N. "Ding" Darling (FL)	546,770	853,594	749,146
Lacassine (LA)	6,869	8,912	14,349
Laguna Atascosa (TX)	82,274	87,829	72,144
St. Marks (FL)	374,860	288,807	270,836

Data from U.S. Fish and Wildlife Service.

sandhill crane. Sandhill cranes once nested in small separate colonies along the Gulf coastal plains of Louisiana, Mississippi, Alabama, and Florida. The Mississippi sandhill crane, which was described as a new subspecies in 1972, has the smallest of the world's crane populations. Being nonmigratory, the birds were year-round residents of southern Jackson County, Mississippi. They thrived in an environment of acid, infertile, and water-logged soil. This afforded them a degree of isolation. However, in the mid-1950's, a combination of timber management practices consisting of pine tree plantations, drainage, and access roads threatened their existence. They were officially listed as an endangered species in 1973. The refuge for their protection was established in 1975.

Other species enjoy the same protection either individually or in concert with others. Table 5-8 lists threatened or endangered species that use or live in the national wildlife refuges in the Gulf of Mexico region. The American alligator appears in both categories since it is endangered in some areas and only threatened in others.

5.6.2 Hunting

Millions of Americans go to the woods and coastal marshes each fall in pursuit of game, making hunting a popular outdoor

Table 5-8.--List of endangered or threatened species that use or live within national wildlife refuges in the Gulf states.

ENDANGERED

American alligator
American crocodile
Arctic peregrine falcon
Atlantic leatherback turtle
Attwater's greater prairie chicken
Eastern brown pelican
Florida Everglade kite
Florida manatee
Florida panther
Gray bat
Houston toad
Indiana bat
Jaguarundi
Key deer
Mississippi sandhill crane
Ocelot
Peregrine falcon
Red-cockaded woodpecker
Southern bald eagle
Watercress darter
Whooping crane

THREATENED

American alligator
Eastern indigo snake
Green turtle
Loggerhead turtle

Data from U.S. Fish and Wildlife Service.

activity. In 1980, 17.4 million hunters (aged 16 and older) took 314 million hunting trips totalling 330 million days of hunting, an average of 19 days per hunter. Including special equipment expenses, as estimated by the U.S. Fish and Wildlife Service, hunters spent $8.5 billion on their sport in that year. Among the high-expenditure items hunters use are firearms, telescopic sights, special clothing, rubber boots, decoys, boats, binoculars, wildlife guides, and hunting dogs.

The Gulf of Mexico region with its broad coastal areas with habitat suited to migratory waterfowl and overwintering birds is one of the most attractive areas for hunting game in the nation. Florida is on the Atlantic Flyway. Texas is on the Central Flyway. Alabama, Louisiana, and Mississippi are on the Mississippi Flyway. It has been estimated that more than two-thirds of the Mississippi Flyway's waterfowl spend the winter in Louisiana's coastal wetlands. The number of waterfowl arriving in Texas is also large.

Deer hunting in Gulf coastal areas, either by gun or by bow and arrow, is also a popular fall sport. Looking at the figures regionally, the U.S. Fish and Wildlife Service found that in 1980 in the Gulf states hunters took part in 66,525,000 participant hunting days and spent more than $588 million for food, lodging, and travel to take part in this activity. In 1980, Texas had the highest number of hunting participant days and trip expenditures for any state in the nation. Table 5-9 gives the number of licensed hunters in the Gulf states for 1983 through 1985. The Gulf states had over 2.3 million licensed hunters in 1985 with over 1.1 million of them residing in Texas.

In addition to regular hunting licenses, most of the states of the Gulf region require that a state waterfowl or duck stamp be purchased in order to hunt for migratory waterfowl (Louisiana requires special waterfowl fees only from out-of-state residents). In all states, a Federal Migratory Bird Hunting and Conservation Stamp (popularly referred to as a "duck stamp") is also required for migratory waterfowl hunting. Table 5-9 gives the total expenditures for hunting licenses and stamps in each of the Gulf states for both resident and nonresident hunters for 1985 (excluding Federal duck stamp sales). It is clear from these figures alone that hunting is important to state economies.

The Federal duck stamp program is interesting, and its relationship to wildlife management provides one of the clearest indications of how fall weather may affect the hunting of waterfowl and hence the recreational economy. The program was begun for the purpose of improving conditions on breeding grounds and wintering areas through the use of fees from the sale of stamps. Stamps are normally purchased early in the fall, coinciding with the migration of birds and the opening of the hunting season. Preceding this, the U.S. Fish and Wildlife Service issues forecasts of the number of birds expected to

Table 5-9.--Number of paid* hunting license holders and gross revenue from license/permit sales, Gulf states, 1983-1985.

	1983	1984	1985	1985 Revenue ($)
Alabama	288,427	286,198	283,389	$4,327,339
Florida	257,739	254,802	257,467	4,658,473
Louisiana	413,332	392,263	396,490	2,829,795
Mississippi	303,572	293,906	295,800	3,438,005
Texas	1,050,496	986,707	1,100,550	9,061,804
Total Gulf region	2,313,566	2,213,876	2,333,696	$24,315,416

*A paid license holder is one individual regardless of the number of licenses the person may purchase.

Data from U.S. Fish and Wildlife Service.

arrive in the Gulf region. These forecasts are published in local newspapers and give bird hunters an opportunity to decide on whether to buy state licenses and stamps and the Federal duck stamp. Because of poor breeding conditions in the spring, the number of birds predicted to arrive in the fall of 1985 was low. As Table 5-10 indicates, these lowered forecasts were reflected in the sales of the Federal duck stamp in the 1985-86 season. Total sales in the Gulf states dropped from 293,203 stamps sold in the 1984-85 hunting season to 252,821 sold in 1985-86, a decline of 13 percent.

As the season progressed, the weather also contributed to this lowering of Federal duck stamp sales and brought about other economic losses, particularly in Louisiana and Florida. This came from the onset of a tropical cyclone activity as the hunting season was beginning. Hurricane Juan devastated the coast of Louisiana from October 26 through November 1, keeping hunters away and causing ducks to fly away from the storm. In Louisiana the drop in Federal duck stamp sales between the 1984-85 and 1985-86 season was 16 percent. A wildlife official has estimated that the direct value of duck hunting in Louisiana is $40 to $50 million each hunting season. Part of this economic benefit was lost because of the hurricane. Florida was also impacted by tropical cyclones during duck-hunting season, and duck stamp

Table 5-10.--Number of Migratory Bird Hunting and Conservation Stamps ("duck stamps") sold, by hunting season, Gulf states, 1983-1984 through 1985-1986.

	1983-1984	1984-1985	1985-1986*
Alabama	11,163	11,509	10,677
Florida	22,740	25,014	17,990
Louisiana	124,699	121,529	102,048
Mississippi	23,212	23,306	19,348
Texas	111,512	111,845	102,758
Total Gulf states sales	293,326	293,203	252,821

*Preliminary figures.

Data from U.S. Fish and Wildlife Service.

sales between 1984-85 and 1985-86 dropped 28 percent indicating economic losses from a decline in participation in the sport. However, since the number of duck hunters in Florida is far less than than the number in Louisiana, the economic impacts to the state economy there were not as great as in Louisiana.

SECTION 6

TRANSPORTATION

The Gulf of Mexico is used heavily for transportation. Goods are moved by vessels and barges through intercoastal waterways, including the new intracoastal transportation system, the Tennessee-Tombigbee Waterway (Tenn-Tom). The Tenn-Tom stretches 234 miles from the Tennessee River. The Tenn-Tom is a system that links the port of Mobile to waterways throughout a number of eastern states, the Gulf, and world trade areas (Figure 6-1).

United States Department of Interior studies show that grain and other products of the Mississippi Basin are shipped to the Gulf, while foreign goods and products from other parts of the country are moved back up the river and along the coast. Several Gulf ports experienced a decline in tonnage and revenue during the 1985 year primarily due to the high price of U.S. grain on the world market.

There are seven major ports in the Gulf of Mexico region based on U.S. Department of Commerce, Bureau of Census data. New Orleans and Houston, two of the largest ports in the United States, ship large amounts of oil, grain, and grain products (Table 6-1). In an effort to stay competitive with the fluctuation of world trade, some Gulf ports have taken on international sister port agreements involving the study and exchange of port operations and facilities to enable better trade opportunities.

The Lousiana Offshore Oil Port (LOOP), the nation's first deepwater port facility, located 19 miles offshore, handles petroleum imports via pipeline. The import of crude oil is handled at the LOOP. Accidental spills of oil, fuel, and hazardous substances are seen in the Gulf of Mexico area regularly. Spills that are 100 or more gallons are normally from offshore marine facilities, land facilities, and tank trucks.

6.1 Shipping and Related Shore Activity

At the port of New Orleans foreign waterborne commerce totalled 75.5 million pounds in 1985, a 6.2 percent decline over 1984. Tonnage for bulk cargo such as grain, animal feed, and wheat flour tonnage decreased during the fiscal year at the port, contributing to the overall decline. New Orleans is the first U.S. port to design an automation system link between the port, its maritime community, and U.S. Customs Automated Commercial System. The system, Computerized Reporting and Expediting of Shipments to Control Essential New Orleans Trade (CRESCENT), is a community service center that allows faster communication between shippers and operators and faster documentation of cargo. The port signed sister port agreements with the port of Kushiro

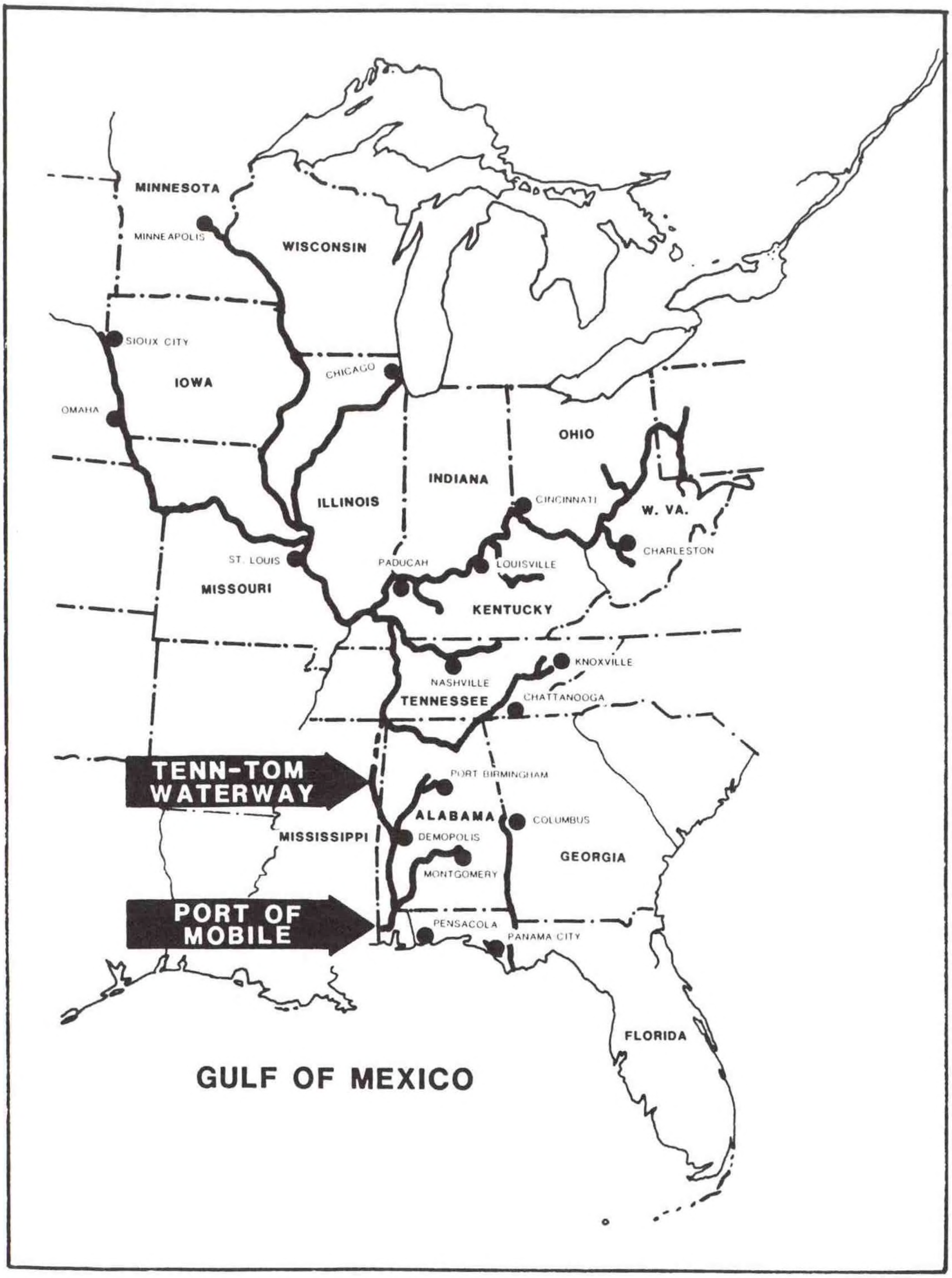

Figure 6-1.--The Tennessee-Tombigbee Waterway ties together 16,000 miles of the nation's river systems by way of Port of Mobile.

Table 6-1.--Cargo terminals and ports, Gulf of Mexico, 1985.

Containers	Liquid Bulk	Heavy Lifts
Mobile New Orleans Houston Tampa Corpus Christi Galveston	Baton Rouge New Orleans	New Orleans Mobile Houston Galveston Baton Rouge
Roll-on/Roll-off	**Dry Bulk & Grain**	**LASH/Seabee**
New Orleans Houston Mobile Galveston	Baton Rouge Mobile Houston Galveston	New Orleans Houston Mobile Baton Rouge Galveston
Break-Bulk/Gen. Cargo		**Railway Services**
New Orleans Houston Baton Rouge Mobile Corpus Christi Galveston		New Orleans Houston Corpus Christi Mobile Galveston Baton Rouge
Passenger Liners		
New Orlean Houston		

Data from Port Authorities of Baton Rouge, Houston, Mobile, Galveston, Tampa, Corpus Christi, and New Orleans.

and the freeport of Monrovia, increasing its number of sister ports to three.

Houston signed sister port agreements with the port of Dalian and with South America's largest coffee port, the port of Santos, Brazil. The port of Houston ranks third in the U.S. in total tonnage and second in total foreign waterborne commerce. In 1985 total foreign waterborne commerce totalled 81.9 million pounds, a 13 percent decline from 1984. The tonnage of the leading imports, petroleum and petroleum products, increased by 13 percent between 1984 and 1985.

The port of Baton Rouge is an inland port in the Gulf region on the Mississippi River. Total tonnage slightly increased to 39.5 million pounds in 1985 compared to 39.4 million pounds during 1984.

Both revenue and tonnage showed slight decreases at the port of Corpus Christi in 1985. Total tonnage handled was 43.9 million pounds in 1985 compared to 46.8 million pounds in 1984 (Table 6-2). Oil and petrochemical products account for 80 percent of the tonnage moving through Texas ports. At Corpus Christi in 1985 82 percent of the total tonnage handled was petroleum products, 7 percent was dry cargo, 7 percent was chemicals, and 4 was percent grain.

Corpus Christi is the only U.S. port with foreign zones that include oil refineries. Foreign zone number 122 was completed during the year. Warehouses and factories located in the zones create an opportunities for more jobs. Additional storage and marshalling area construction and the inner harbor deepening project commenced in 1985 (see Section 6.3).

At the nation's seventh largest port, Tampa, general cargo for the year showed a slight decrease from the previous year. A 62 percent decline in citrus exports, caused by crop damage from two winter freezes, accounted for much of the decline. Thirty-one thousand tons of citrus export were shipped in 1985 compared to 85,500 tons in 1984. The addition of a new scrap metal terminal increased the export of scrap metal by 47 percent over the previous year. Foreign waterborne commerce totalled 31.5 million pounds, a 28.1 percent decrease from 1984.

Three T-5 tankers, contracted by Tampa Shipyard, arrived during the year at the port of Tampa for use by the Military Sealift Command for transporting liquid materials by the U.S. Navy. A new vessel traffic control system added at the port is monitoring incoming and outgoing vessels and at the same time providing an extra measure of safety for ships navigating the main channel.

Table 6-2.--Foreign Waterborne Commerce (exports and imports), total tonnage and dollar value at leading ports, Gulf of Mexico, 1984 and 1985.

	Tonnages (millions of pounds)			Dollar Values (millions of dollars)		
Port	1984	1985	% Change 1984-1985	1984	1985	% Change 1984-1985
Houston	94.5	81.9	-13.3	19.8	19.1	-3.5
New Orleans	80.5	75.5	- 6.2	12.0	11.1	-7.5
Corpus Christi	46.8	43.9	- 6.2	3.6	3.5	-2.9
Tampa	43.8	31.5	-28.1	2.5	2.3	-8.0
Baton Rouge	39.4	39.5	+ 0.3	2.8	2.6	-7.1
Mobile	31.4	36.2	+15.3	1.4	1.3	-7.1
Galveston	19.6	11.7	-40.3	2.7	1.8	-33.3
Totals	356.0	320.2	-10.1	44.8	41.7	-6.9

Data from U.S. Department of Commerce Bureau of the Census; U.S. Waterborne Exports and General Imports.

The primary operations of the Alabama State Docks Department (ASD) are at the port of Mobile, with affiliations at harbors, seaports, and riverports within the state. One of the most significant highlights at the port for the year was the opening of the Tenn-Tom, almost two years earlier than forecast. The new waterway, which links 14 states, is an inland shipping route for barges and other shipping traffic. Products such as coal, metallic ore, chemicals, grain, pulp, paper, and paper products are the major commodities shipped along the Tenn-Tom.

The opening of the Tenn-Tom contributed to the increase in tonnage seen at the terminals within the port of Mobile. The McDuffie Terminal Export Coal Plant, for example, showed a large increase in shipping for the year. Coal exports rose 20 percent in 1985 compared to 1984. The Bulk Materials Handling Plant handles most of the raw materials used by mills and manufacturers within Alabama. During 1985 an increase of 4 percent was seen at the Public Grain Elevator. Grain exports totalled 35.1 million bushels in 1985, compared to 22.4 bushels in 1984, a 56 percent increase

6.2 Dredging Summary

The major ports of the United States have voiced concern that the U.S. is lagging behind our trade partners in deepening our ports. Many ports in the U.S. have deepened their channels to 42 feet or more to attract larger vessels that are able to load more cargo and move more goods, at the same time lowering transportation costs (Table 6-3).

The Gulf of Mexico ports undertook numerous dredging activities during the year. The ports of Baton Rouge and port of New Orleans, both on the Mississippi River, deepened their harbors a few feet during the year. Acquiring greater depth allows larger vessels to enter harbors and channels while possibly reducing the congestion caused by the constant traffic of smaller vessels. The port of Tampa has deepened its channel from 34 feet to 43 feet in the past nine years. According to the port authority, nearly one-third of Corpus Christi's inner harbor length is dredged to 45 feet, and 4.4 million cubic yards of material were removed. Of the seven ports, Corpus Christi was dredged the deepest in 1985. Material removed was dumped into spoil islands and other approved environmental sites around the Gulf of Mexico.

Both Galveston Channel and Harbor were dredged to 40 feet. The dredging was begun in May 1985 and was completed in September 1985. Four million cubic yards of material were removed to appropiate sites. At the port of Houston, part of the channel, Redfish Reef to Carpenter Bayou, is dredged to 40 feet, and another part, Sims Bayou, is dredged to 36 feet. Dredging activities at the port of Mobile include pipeline dredging at

Table 6-3.--Summary of dredging operations of the leading ports, Gulf of Mexico area, fiscal year 1985 (1 October 1984 to 30 September 1985).

Project Name	Depth (feet)	Start Date	End Date	Amount (dollars)	Quantity Removed (cubic yards)
Port of Baton Rouge and New Orleans:					
Baton Rouge Harbor (Devil's Swamp)	12	01Aug85	07Oct85	206,300	196,525
Miss River - New Orleans Harbor	25-35	31Jan84	30Jan85	80,600	320,705
Miss River - New Orleans Harbor	25-35	31Jan85	30Jan86	1,019,800	2,276,918
Port of Tampa Bay area:					
Tampa Bay Channel	43	May85	Dec85	23,612,920	3,141,272
Port of Corpus Christi: (Ship Channel)					
Beacon 82 thru and including Chemical Turning Basin	40-45	22Mar85	30Sep85	1,474,200	960,360
La Quinta Junction to Beacon 82	45	06May85	02Aug85	1,638,223	4,473,808
Channel to La Quinta and Turning Basin	45	03Aug85	30Sep85	547,599	1,273,990
Port of Galveston: (Harbor and Channel)					
Galveston Channel	40	14May85	30Sep85	1,764,894	4,059,350
Port of Houston: (Ship Channel)					
Redfish Reef to Morgan Point	40	01Oct84	01Nov84	671,035	47,103
Sims Bayou to and including Turning Basin	36	01Oct84	19Dec84	179,881	444,992
Morgan Point to Carpenter Bayou	40	06Oct84	24Mar85	2,622,030	3,252,658
Port of Mobile					
Bar Channel	42	Sep85	Sep85		620,000

Data from U.S. Army Corps of Engineers.

Project Channels and Bar Channel. Dredging at both channels are on an annual basis. The Bar Channel was last dredged during September 1985.

6.3 Accidental Spills of Oil and Hazardous Substances

According to the U.S. Coast Guard spill data, a total of 131 vessel spills occurred in the Gulf in 1985 compared to 175 spills in 1984. Figure 6-2 shows January 1984 with the largest number of spills, 36. Improper valve operations, corrosion, and material defects were contributing factors to the 14 spills in January 1985. The majority of spills were oil, jet fuel, and kerosene. No spills occurred in September 1985 compared to 14 in September 1984.

A number of spills from vessels in the Gulf are 100 or more gallons as shown in Figure 6-3. The months of February, July, September, November, and December 1984 totalled 14 spills from vessels, compared to zero spills during the same months in 1985. The largest spill in 1985 occurred on August 18, when 1.2 million gallons of oil and fuel entered the Gulf from a tank-type vessel.

Figure 6-4 shows the total number of spills of 100 or more gallons from non-vessels during 1984 and 1985. The largest spill, 21,000 gallons, occurred offshore in July 1985 and consisted of oil, rosin, and other miscellaneous liquids.

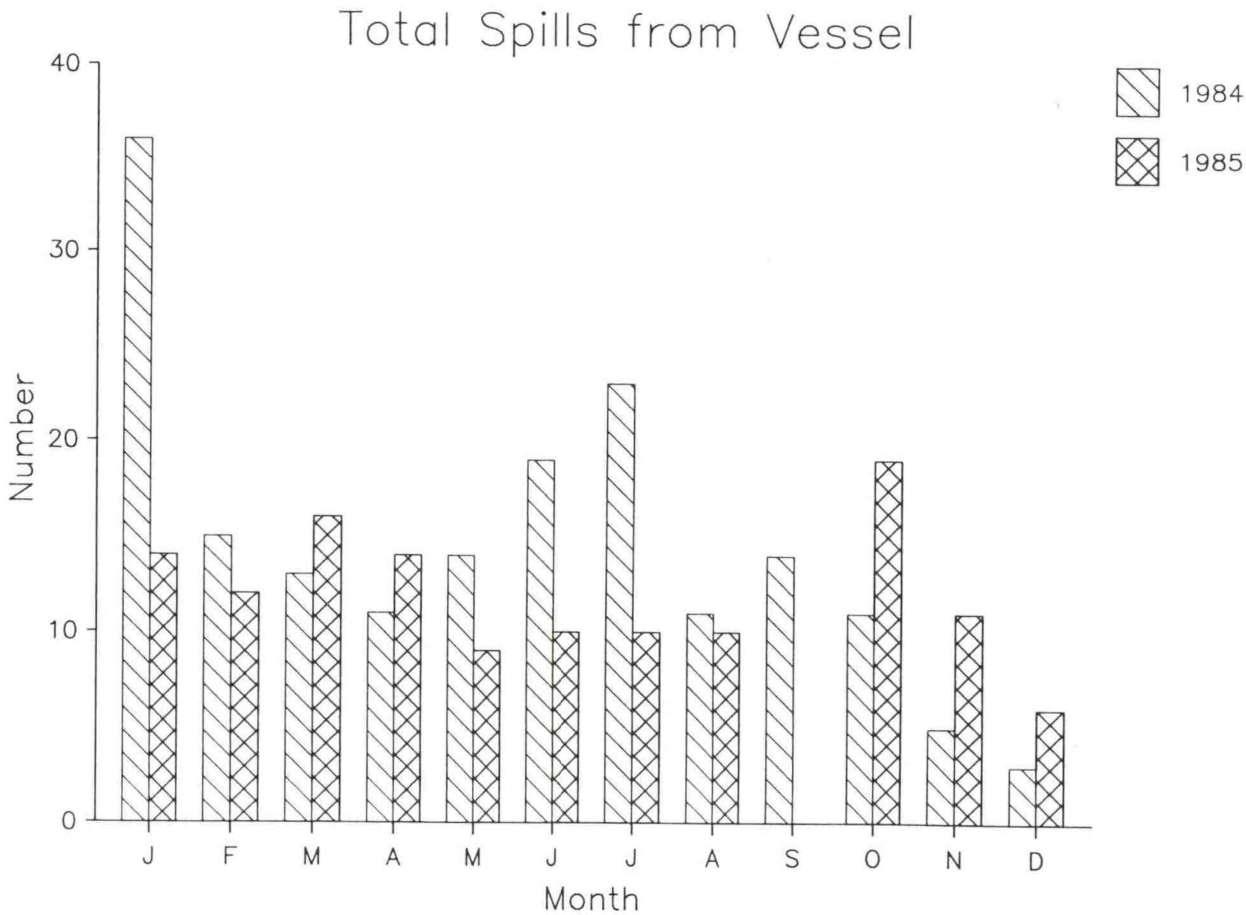

Figure 6-2.--Total number of spills from vessels, Gulf of Mexico, 1984 and 1985. Missing columns indicate zero number of spills.

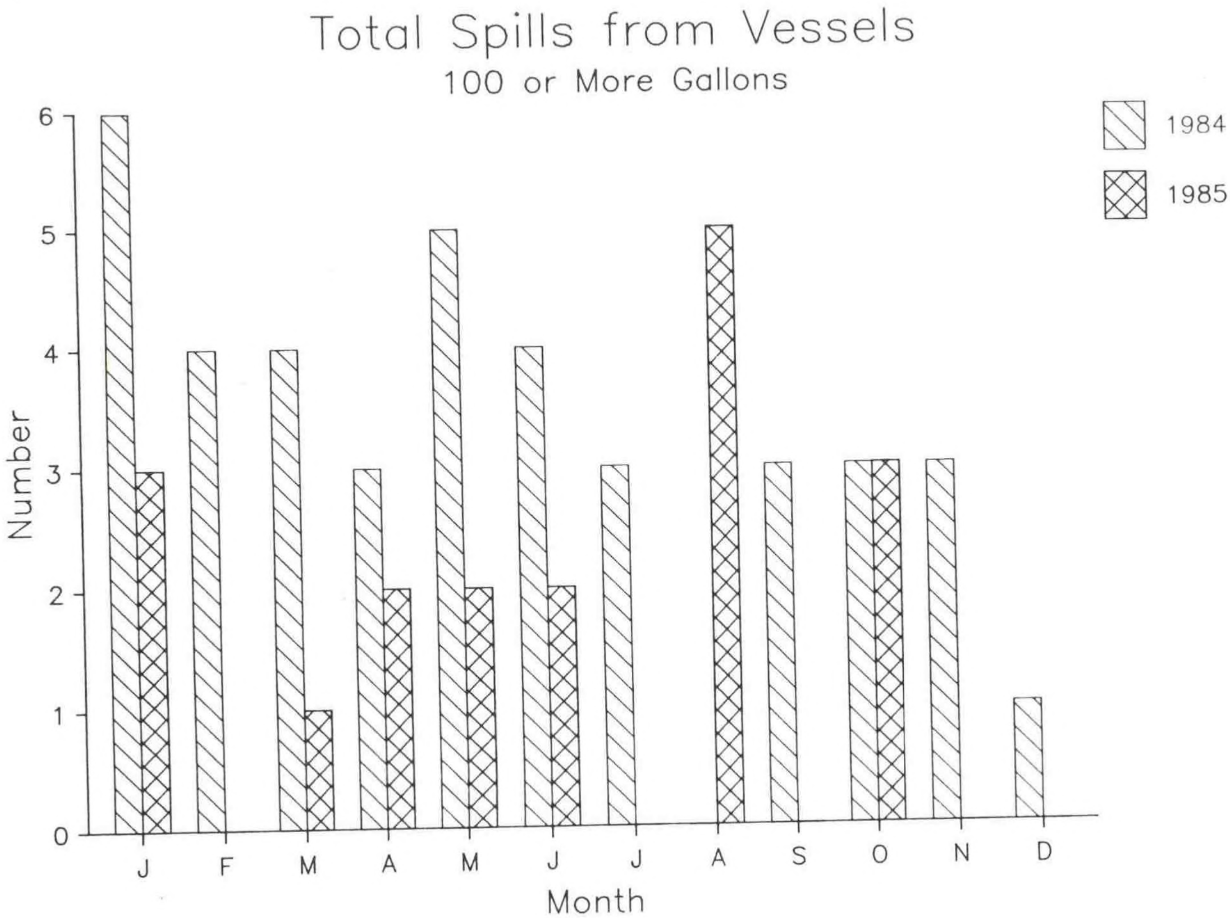

Figure 6-3.--Total number of spills of 100 or more gallons from vessels, Gulf of Mexico, 1984 and 1985. Missing columns indicate zero number of spills.

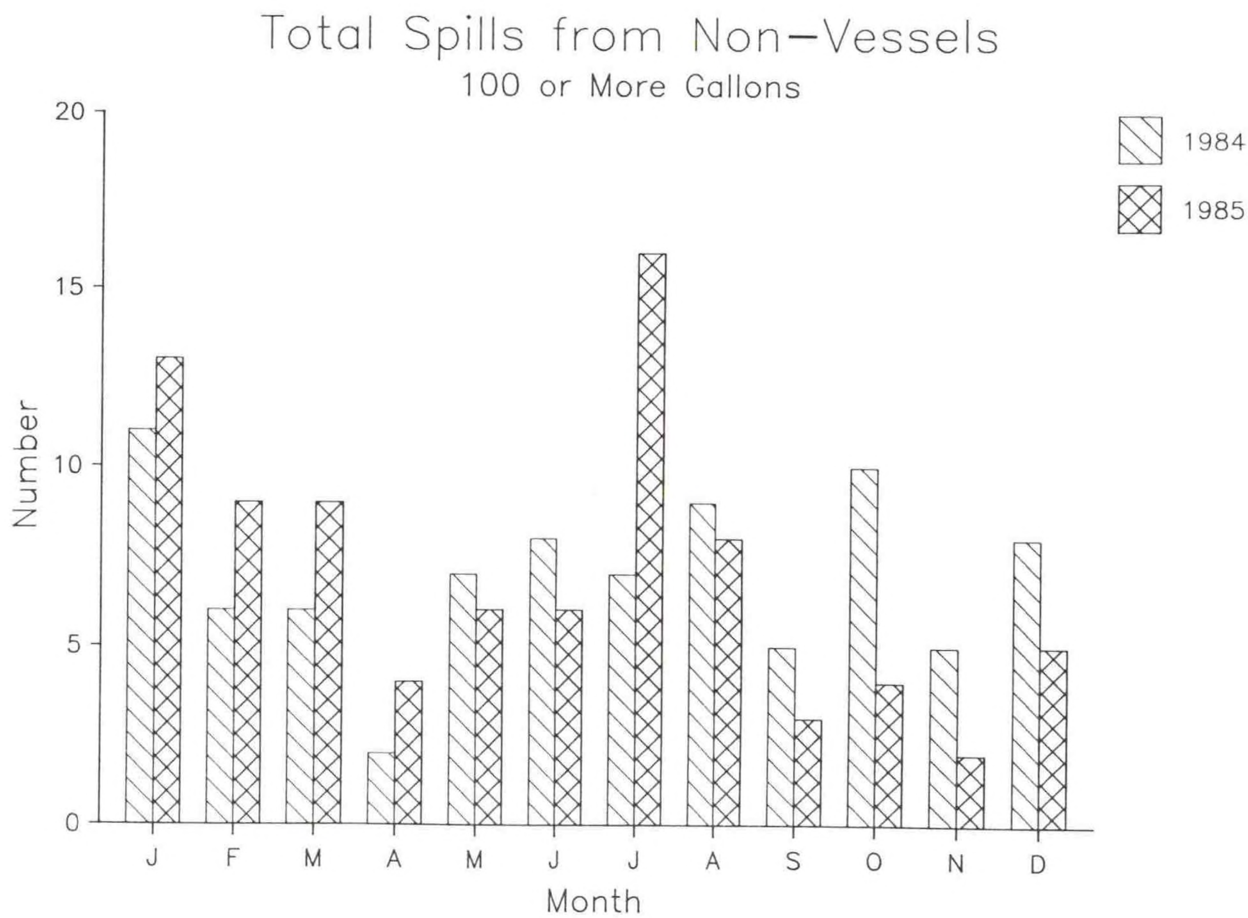

Figure 6-4.--Total number of spills of 100 or more gallons from non-vessels, Gulf of Mexico, 1984 and 1985.

SECTION 7

SPECIAL ISSUES

Dismantling Out-of-Service Oil Platforms

Major environmental and fishing issues have been raised by the current and projected dismantling of out-of-service oil rigs in the Gulf of Mexico. It is in the area under some of the most popular fishing platforms within 25 miles of shore where oil and gas fields are being rapidly depleted and have the shortest remaining life expectancies. There are now approximately 4,000 of these platforms in the Gulf ready for dismantling. The outcome of this issue has important consequences both for the preservation of protected or threatened species in the Gulf and for the future fishing, particularly recreational fishing.

Under Federal law, dismantling of out-of-service oil and gas platforms must be done within one year of the time of lease termination. The drop in world oil prices caused oil companies to shut down many more of these platforms sooner than expected. Dismantling is frequently accomplished by dropping an explosive charge down the legs of the platforms. The blast severs the legs 15 feet below the mudline. After the structure is severed, it is towed to shore, where it is frequently recycled as scrap.

Environmental groups such as Greenpeace have raised concerns about the safety of turtles, marine mammals, and fish in the vicinity of the explosions. The National Marine Fisheries Service of the National Oceanic and Atmospheric Administration and the Minerals Management Service of the Department of the Interior have been in informal consultation about the matter. Responsibility of these agencies arises under the Endangered Species Act and Marine Mammal Act and the authority of the Minerals Management Service over oil and gas leases on the outer continental shelf. No definite action on the matter is likely to be forthcoming until the spring of 1987, when the two agencies will meet on matters relating to the disposition of an Environmental Impact Statement for future oil and gas leases in the Gulf. In the interim, an informal arrangement between the parties allows dismantling of the rigs through explosive charges on a case-by-case basis. During this period, the impacts of the explosions on marine wildlife will be observed and various alternative methods may be employed. Among the alternatives that may be tried are the use of less potent charges, the placing of charges in the mud, and the employment of divers to cut the rigs.

The dismantling of the rigs may have significant consequences for fishing, particularly off Louisiana, where most of the oil and gas platforms are located. Soon after the introduction of oil and gas platforms, Louisiana fishermen realized the oil rigs were acting as artificial reefs and attracting marine life. These rigs have become some of the favored fishing locations of recreational fishermen.

The reason rigs work well as reefs is the network of underwater support columns and braces of the rigs. These structures rise through the entire water column. A platform standing in 200 feet of water provides an estimated two acres of hard substrate to which algae, sponges, crabs, barnacles, anemones, mussels, and many other species attach themselves. In Louisiana waters less than 300 feet deep, oil and gas structures may account for over 90 percent of all hardbottom habitat. The platforms provide benthic, midwater, and upper water habitats. The rigs allow species to expand their ranges and exist where they had been unable to live previously. In the Gulf of Mexico, 20 to 50 times more fish have been found under and near platforms than live in nearby areas with soft bottoms. Before the recent oil price plunge, oil industry analysts forecast that 1700 oil and gas producing structures would be removed by the year 2000, eliminating 50 percent of Louisiana's nearshore hardbottom habitat. Recent developments in oil and gas pricing may result in acceleration of the demolition of rigs and, hence, in the greater destruction of this artificial habitat.

The prospect that more than half of Louisiana's nearshore structures will be removed by the year 2000 prompted action by the state. Among the undesirable consequences that might result are a significant decrease in recreational and commercial fishing with negative economic impacts on coastal communities, increased pressure on nearshore species as fishermen change commercial target species, and a decline in the flourishing charterboat and tourism industry. A way to utilize existing structures as reefs was needed. Texas has had some experience with the problem, and Florida has used rigs towed from other states' waters as reef material.

The Federal government laid groundwork for comprehensive action by the passage of the National Fishing Enhancement Act of 1984. Title II of this act places primary responsibility for artificial reef development with the states. In 1986 Louisiana passed a Fishing Enhancement Act. The Louisiana law provides a plan for the development of artificial reefs. Although it does not limit itself to oil rigs as reef material, the Act was clearly designed with rigs in mind. Under the Act, the State of Louisiana is the permittee for artificial reefs, and its jurisdiction includes all territorial waters and the Federal Exclusive Economic Zone out to international boundaries.

Under the law, site selection is the first stage in the development of an artificial reef. Exclusion mapping is done to determine inappropriate sites. After this, sites most suited for reef construction are identified based on scientific information and comments from user groups, the oil and gas industry, and Federal and state agencies. Once a site is selected, oil and gas structures may be used as reef material in any of the following ways: (1) an existing structure may be left standing; (2) an existing structure may be cut at any distance below the waterline and left standing with the top portion taken away; (3) the structure may be cut at any distance below the waterline and the top portion allowed to topple leaving the entire structure in place; (4) the structure may be cut off 15 feet below the mudline and towed to a permitted site; or (5) a combination of any of these methods.

The plan being developed in Louisiana under the Act will look toward three areas for development of artificial reefs: (1) those for recreational fishing that would exist within a 25-mile radius of popular boat landings and facilities, (2) those for commercial fishing located between 25 and 75 miles offshore in 200-400 foot water, and (3) those for deepwater marine sanctuaries for ecologically important marine fishes.

Louisiana's Fishing Enhancement Act is a comprehensive program for developing artificial reefs and for utilizing existing oil and gas structures, which have proved productive for marine life over the years. The program is innovative in that it attempts to integrate the needs, resources, and responsibilities of the oil companies, the State, and the public to solve a problem and produce a positive outcome.

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