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to Review the Draft Action Plan for the
Wider Caribbean Region

Caracas, Venezuela
28 January - 1 February 1980

CARIBBEAN ENVIRONMENT PROGRAMME
ACTION PLAN

The status of Oil Pollution and Oil Pollution Control in the Wider Caribbean Region

prepared with the co-operation of
the Inter-Governmental Maritime Consultative Organization

UNEP / CEPAL
1979

P R E F A C E

In accordance with resolution 2997 (XXVII) of the General Assembly, UNEP was established "as a focal point for environmental action and co-ordination within the United Nations system". The Governing Council of UNEP defined this environmental action as encompassing a comprehensive, transectoral approach to environmental problems which should deal not only with the consequences but also with the causes of environmental degradation.

The UNEP Governing Council has designated "Oceans" as a priority area in which it will focus effort to fulfil its catalytic role. In order to deal with the complexity of the environmental problems of the oceans in an integrated way, it has adopted a regional approach as exemplified by its Regional Seas Programme.

Although the environmental problems of the ocean are global in scope, a regional approach to solving them seemed more realistic. By adopting a regional approach, UNEP felt it could focus on specific problems of high priority to the States of a given region thereby more readily responding to the needs of the Governments and helping to mobilize more fully their own national resources. It was thought that undertaking activities of common interest to coastal States on a regional basis should, in due time, provide the basis for dealing effectively with the environmental problems of the oceans as a whole.

Two elements are fundamental to the Regional Seas Programme:

(a) Co-operation with the Governments of the regions. Since any specific regional programme is aimed at benefiting the States of that region, Governments are encouraged to participate from the very beginning in the formulation and acceptance of the programme. After acceptance, the implementation of the adopted programme is carried out by national institutions which have been nominated by their Governments.

(b) Co-ordination of the technical work through the United Nations system. Although the regional programmes are implemented predominantly by Government-nominated institutions, a large number of the United Nations specialized organizations are called upon to provide assistance to these national institutions. UNEP acts as an overall co-ordinator although in some cases this role is limited to the initial phase of the activities. Thus the support and experience of the whole United Nations system contributes to the programme.

The components of a regional programme are outlined in an "action plan" which is formally adopted by the Governments before the programme enters an operational phase.

Each action plan consists of three standard components as adopted by the United Nations Conference on Human Environment (Stockholm, 5 - 18 June 1972) and endorsed by subsequent meetings of UNEP's Governing Council. They are:

(i) Environmental assessment. The assessment and evaluation of the causes, magnitude and consequences of environmental problems is an essential activity providing the basis for assistance to national policy-makers to manage their natural resources in an effective and sustainable manner.

(ii) Environmental management. A wider range of activities requiring regional co-operation falls under this component: rational exploitation of living resources, utilization of renewable sources of energy, management of freshwater resources, disaster preparedness and co-operation in cases of emergency, etc. Regional conventions, elaborated by specific technical protocols, provide usually the legal framework for the action plan and proved to be in many regions an excellent tool in the hands of environmental managers.

(iii) Supporting measures. The national institutions are the institutional basis for the implementation of the action plan. Large-scale technical assistance and training are provided to them where necessary to allow their full participation in the programme. Existing global or regional co-ordinating mechanisms are used when appropriate. However, specific regional mechanisms may be created if Governments feel they are necessary. Public awareness for environmental problems is stimulated as essential supporting measure for the action plan. Financial support is initially provided by UNEP and other international and regional organizations, but, as the programme develops, it is expected that the Governments of the region assume increasing financial responsibility.

At present there are eight regional seas areas where action plans are operative or are under development: The Mediterranean (adopted in 1975), the Red Sea (adopted in 1976), the Kuwait Action Plan Region (adopted in 1978), the West African Region (under development, adoption expected in 1980), the East Asian Seas (under development, adoption expected in 1980), the South-East Pacific (under development, adoption expected in 1980), the South-West Pacific (under development, adoption expected in 1981) and the Wider Caribbean Region (under development, adoption expected in 1980).

The following document has been prepared as one of the contributions to the development of the action plan for the Wider Caribbean Region. It is an effort to identify the status of oil pollution and oil pollution control problems of the region and thereby to assist the States of the region in their decisions concerning the national or regional activities designed to mitigate the effects caused by pollutants entering the marine environment of their region.

The preparation of this document was commissioned by UNEP's Regional Seas Programme Activity Centre which is charged with the overall co-ordination of UNEP-sponsored regional seas programme. It was prepared under sponsorship of the Inter-Governmental Maritime Consultative Organization (IMCO) by a consultant and hence does not necessarily reflect the views of either UNEP or IMCO.

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TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

LIST OF FIGURES

LIST OF FIGURES
(continued)

LIST OF FIGURES
(continued)

LIST OF TABLES

LIST OF TABLES
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LIST OF TABLES
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SECTION 1

INTRODUCTION

The objective of this report is to provide a knowledge base regarding oil production, oil transportation, oil pollution and oil pollution control in the wider Caribbean area. The document is intended to serve as a source document for future programs in the Caribbean Sea and Gulf of Mexico areas which will lead to more effective prevention of oil pollution and control of such pollution when it occurs.

The report is divided into seven sections and five Appendices.

Section 2 provides information on the geography, oceanography, meteorology, biology and geology of the Caribbean and Gulf of Mexico system.

Section 3 provides information regarding coastal and offshore oil production in the region. Information is also provided on the capacity and location of major coastal refinery systems. High risk areas for production or refinery related spills are designated.

Section 4 describes crude oil and by product transportation through the region. Ports, transhipping terminals, lightering locations, and routes generally taken by tankers are shown. The known or expected oil pollution resulting from tanker washings, bilge pumping and other chronic causes are discussed as are past or potential accidental oil spills from transportation related activities. The impact of oil pollution resulting from ocean transportation and its relation to this region is discussed.

Section 5 discusses the potential impact of an oil spill on the environment and economy in areas throughout the region. Specific regional environmental systems and other waste loads imposed on these systems are discussed.

Section 6 discusses the administrative and legal tools used for control of oil pollution on international, national, and local levels. Existing pollution response capability of industry and government is discussed and presented.

Section 7 concludes the report. It contains suggestions with regard to intergovernmental and governmental prevention and control of oil pollution in the wider Caribbean.

Included with this report are Appendices 1 through 6. Appendix 1 is a compilation of facts related to oil pollution control with regard to each major country, island and island system in the wider Caribbean area. Included are maps of the most significant systems. Information is provided about oil pollution control capability and such items as contractors, manpower, communications, lodging, road conditions, legislation, monetary system and banks which would be needed for an oil pollution response.

Appendix 2 contains a directory of those people involved in oil-related industries in each major country.

Appendix 3 contains information on the Clean Caribbean Cooperative and the Clean Gulf Cooperative. These are two major oil spill cooperatives operating in the area.

Appendix 4 provides details on specific pollution incidents in the wider Caribbean region.

Appendix 5 includes the U.S. Water Quality Act relating to oil pollution, the National Plan for Oil Spill Prevention and the U.S. National Contingency Plan as example documents.

Appendix 6 provides conversion figures to interrelate various weight units for oil shipment with both English and metric units.

SECTION 2

BACKGROUND ENVIRONMENTAL PARAMETERS OF THE CARIBBEAN AND GULF OF MEXICO SYSTEM

The general geography, oceanography, meteorology, geology and biology of the region of the Caribbean and Gulf of Mexico are described. in this section.

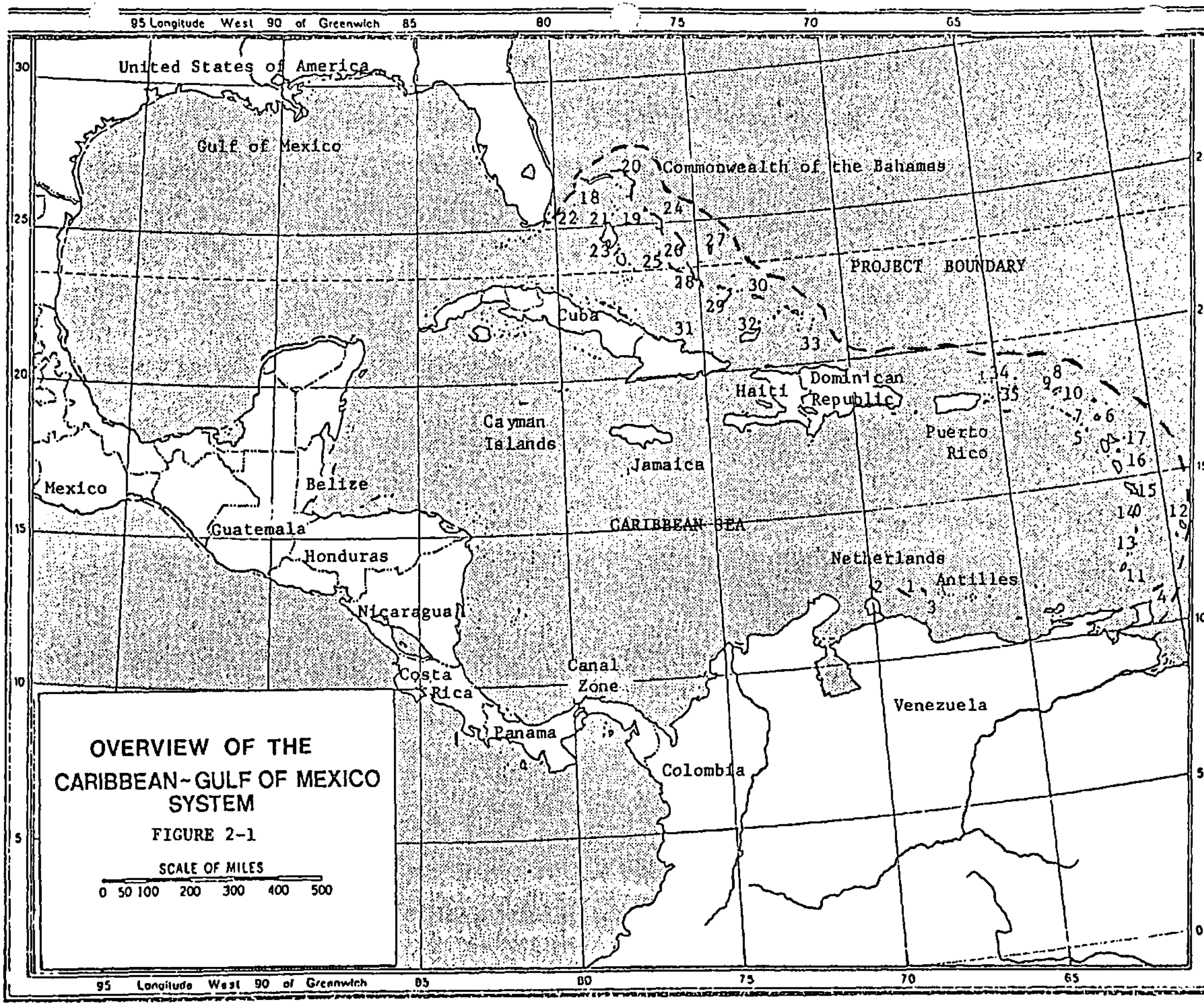
Geography of the Wider Caribbean Region

The Caribbean Sea and the Gulf of Mexico are both semi-enclosed bodies of water surrounded on three sides by the North and South American continents. Figure 2-1 shows the wider Caribbean region which includes the Gulf of Mexico.

The Caribbean part of the system is bordered to the east by the West Indies which includes the archipelago of the Leeward and Windward Islands which stretch northward to the Virgin Islands and Puerto Rico. The boundary extends northwest around the Bahama Islands then to the southern tip of Florida, U.S.A., straight to the northern tip of the Yucatan Peninsula. The remaining portion of the Caribbean Sea is bounded by the northern coasts of Central and South America. Bordering countries of Central America include Belize, Costa Rica, Honduras, Guatemala, Nicaragua, and Panama. Countries of South America include Colombia and Venezuela.

Major large islands of the Caribbean region include Cuba, Hispaniola, Jamaica, and Puerto Rico. Smaller islands include Abacos, Andos, Antigua, Aruba, Bahamas, Barbados, Bonnaire, Caicos, Curacao, Grand Cayman, Martinique, St. Lucia, Tobago, Trinidad, Turks, and the Virgin Islands.

The Gulf of Mexico is bordered to the north entirely by the United States. Coastal states along the Gulf are Texas, Louisiana, Mississippi,



OVERVIEW OF THE CARIBBEAN-GULF OF MEXICO SYSTEM

FIGURE 2-1

LEGEND FOR CARIBBEAN OVERVIEW

1. Curacao Island
2. Aruba Island
3. Bonaire
4. Trinidad and Tobago
5. Montserrat Island
6. Antigua
7. St. Christopher, Nevis and Anguilla
8. St. Maarten
9. Saba Island
10. St. Eustatius
11. Grenada (Windward Islands)
12. Barbados
13. St. Vincent
14. Saint Lucia
15. Martinique
16. Dominica
17. Guadaloupe
18. Grand Bahama Island
19. New Providence Island
20. The Abacos
21. Berry Island
22. Biminis
23. Andros Island
24. Eleuthera
25. Exumas
26. Cat Island
27. San Salvador
28. Long Island
29. Acklins Island
30. Mayaguana Island
31. The Ragged Island Range
32. Inaguas
33. Turks and Calicos
34. British Virgin Islands
35. Virgin Islands of the U.S.

Alabama, and the west coast of Florida. The state of Texas partially borders the Gulf to the west. The remaining part of the Gulf is contained by the entire east coast of Mexico and the northern coast of Cuba.

The total area of the wider Caribbean region is 4.31×10^6 km^2 (1.68×10^6 square miles). The mean water depth is 2.174 kilometers (1.35 miles) giving a water mass volume of approximately 9.37×10^6 km^3. The Cayman trench to the west of Jamaica is the deepest location in the region, or about 6.895 km (4.28 miles).

As with all ocean areas, the wider Caribbean region is divided into physiographic regions called basins. These basins are bordered by submarine sills. Between Jamaica and Honduras, a 200 meter deep sill separates the Yucatan Basin in the northern Caribbean from the main portion of the sea. The main body of the Caribbean is divided into three major basins: (1) Colombian Basin in the west; (2) Venezuelan Basin in the mid-portion of the region; and (3) Grenada Basin to the west of the Leeward and Windward Islands. The latter represents the smaller basin. The Cayman Trough and Mexico Basin are to the north of the sill between Jamaica and Honduras.

Coastline Length of Countries and Islands

Countries and major islands of the Caribbean/Gulf of Mexico system constitute over 21,500 km of coastline in contact with waters of the Caribbean Sea and Gulf of Mexico. Table 2-1 lists the length of coastline of the United States (by state), Mexico, Central America (by country), the northern coast of South America (by country) and the major islands of the West Indies and Bahamas. Values listed were taken from the 1977 World Book Encyclopedia.

Table 2-1

COASTLINE AND SHORELINE LENGTHS BY COUNTRIES AND

MAJOR ISLANDS IN THE WIDER CARIBBEAN REGION

U.S. GULF COAST United States	Coastline*	Shoreline
Alabama	53 mi./ 85.33 km.	607 mi./ 977.27 km.
Florida (west coast only)	770 mi./1,239.70 km.	5,095 mi./ 8,202.95 km.
Louisiana	397 mi./ 639.17 km.	7,721 mi./ 12,430.81 km.
Mississippi	44 mi./ 70.84 km.	359 mi./ 577.99 km.
Texas	367 mi./ 590.87 km.	3,359 mi./ 5,407.99 km.
Total	1,631 mi./2,625.91 km.	17,141 mi./ 27,597.01 km.
Central America		
Mexico	1,708 mi./2,749.88 km.	
Honduras	382 mi./ 615.02 km.	
Belize (Br. Honduras)	175 mi./ 281.75 km.	
Guatemala	53 mi./ 85.33 km.	
Costa Rica	133 mi./ 214.13 km.	
Nicaragua	297 mi./ 478.17 km.	
Panama	426 mi./ 685.86 km.	
Total	3,174 mi./5,110.14 km.	
South America		
Colombia	710 mi./1,143.1 km.	
Venezuela	1,750 mi./2,817.5 km.	
Total	2,460 mi./3,960.6 km.	
Island Countries		
Cuba	2,100 mi./ 3,381.0 km.	
Jamaica	342 mi./ 550.6 km.	
Haiti	672 mi./ 1,081.9 km.	(includes Gonaue and others)
Dominican Republic	604 mi./ 972.4 km.	
Bahamas	1,580 mi./ 2,543.8 km.	
Puerto Rico	311 mi./ 500.7 km.	
Barbados	56 mi./ 90.2 km.	
Grenada	75 mi./ 120.8 km.	
Trinidad & Tobago	292 mi./ 470.1 km.	
Total	6,032 mi./ 9,711.5 km.	
Grand Total	13,297 mi./ 21,408.2 km.	

* straight line length

Geography of the Wider Caribbean Region

The following eight pages contain geographical information on ten regions within the wider Caribbean region including the southern United States, Colombia, Cuba, Jamaica, Belize, Bahamas, Nicaragua, Guatemala, Panama and Venezuela. Maps are included to show cities and main rivers of the southern United States, Colombia, Central América and Venezuela.

United States

Main Rivers:

The contributing river basins from the south of Florida to the Mexican border are listed in Table 2-2. The Gulf of Mexico has been divided into nine parts where the drainage areas and the total discharge are listed. Major rivers are also listed under Table 2-2.

Mexico

Mexico has an area of 1,969, 269 km^2 and a coastline along the Gulf of Mexico of 2,611 km. The population is approximately 58 million (1974).

Main Rivers:

(i) Grande-Bravo del Norte - total length of 2,890 km, catchment area 442,900 km^2. The frontier between Mexico and the United States runs along the river for 1,600 km.

(ii) Panuco - total length is 450 km.

(iii) Papaloapan - total length is approximately 540 km.

(iv) Grijalva

Colombia

Colombia has an area of 1,138,300 km^2 with a coastline in the Caribbean of 1,560 km. The population is 22.9 million (1972).

Main Rivers:

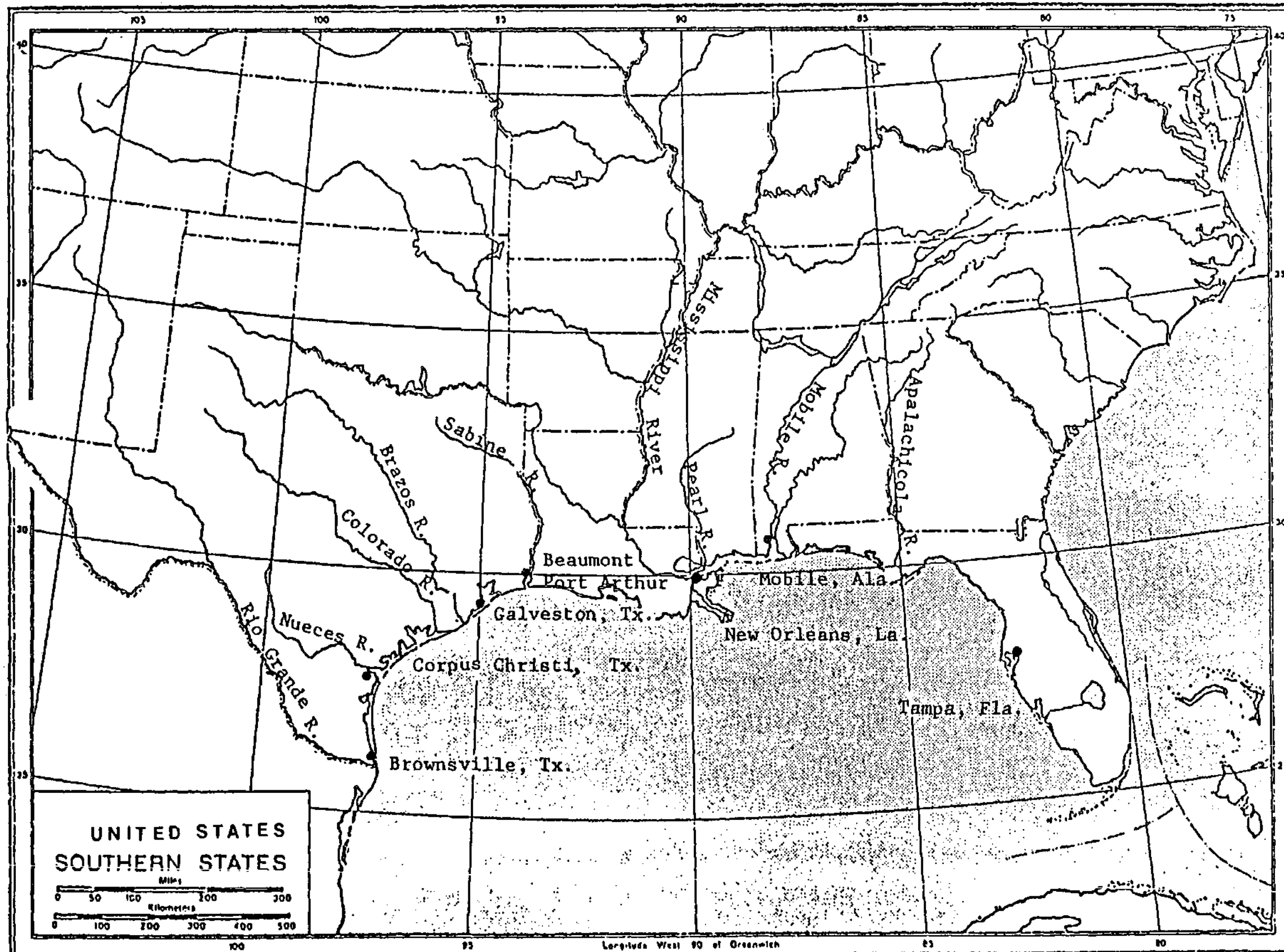
(i) Magdalena - total length 1,550 km, catchment area 200,000 km^2. Examples of chemical data from the lower part of the river (Ducharme, 1975): pH 7.65-8.1; Turbidity JTU: 215-500; Conductivity S: 225; NO_3 ppm: 4.0-22.0; PO_4 ppm: 0.18-3.7; Cu ppm: 0.02

(ii) Sinu - total length 400 km. Examples of chemical data (Ducharme, 1975): pH 7.1-9.1; Turbidity JTU: 100-500; NO_3 ppm: 0.15-3.0; PO_4 ppm: 0.2-1.5; Cu ppm: 0.3-3.6.

Table 2-2

Discharge of Rivers to the Gulf of Mexico

Contributing basin	Drainage area	Total discharge	Discharge from selected river basin
	km^2	m^3sec^{-1}	m^3sec^{-1}
1. Cape Sable to Alligator Creek		71	
2. Peace River to New River	67,600	770	
River basin: Suwanee River			302
3. Apalachicola River	51,800	756	
4. Wetappo Creek to Perdido River	36,800	711	
River basin: Choctawhatchee River			208
Escambia River			195
5. Mobile Bay	114,700	1,818	
River basin: Mobile River			1,788
6. Pascagoula River to Pearl River	51,000	883	
River basin: Pascagoula River			430
Pearl River			365
7. Mississippi River	3,220,900	18,400	
8. Vermilion, Mermentau and Calcasieu Rivers	22,500	306	
9. Sabine River to Rio Grande	875,900	1,407	
River basin: Sabine River			256
Neches River			233
Trinity River			212
Brazos River			176
Colorado River			85
Guadalupe and San Antonio Rivers			67
Nueces River			23
Rio Grande			19
Rounded totals :		25,120	



MAJOR COASTAL CITIES AND RIVERS OF THE SOUTHERN STATES

(iii) Atrato - total length 600 km.

Cuba

Cuba has an area of 114,524 km^2 with a coastline of about 4,000 km. The population is 8.9 million (1973) with approximately 1.8 million in the city of La Habana.

Most rivers are short and run swiftly from the mountains to the sea; the main river, Cauto, is 370 km long.

Jamaica

Jamaica has an area of 11,430 km^2 with a coastline of about 519 km. The population is approximately 2.0 million (1970).

Belize

Belize has an area of 22,965 km^2 with 280 km of coastline. The population is 128,000 (1972) with approximately 40, 000 living in Belize City. The Belize River is the main river.

Bahamas

The Bahamas consist of about 300 islands with a total area of 13,722 km^2. Thirty islands are inhabited, the total popultaion being about 180,000 (1972).

Nicaragua

Nicaragua has an area of 139,699 km^2 with a coastline in the Caribbean of 450 km. The population is about 1.9 million with the main part in the capital, Managua, and on the Pacific side of the country.

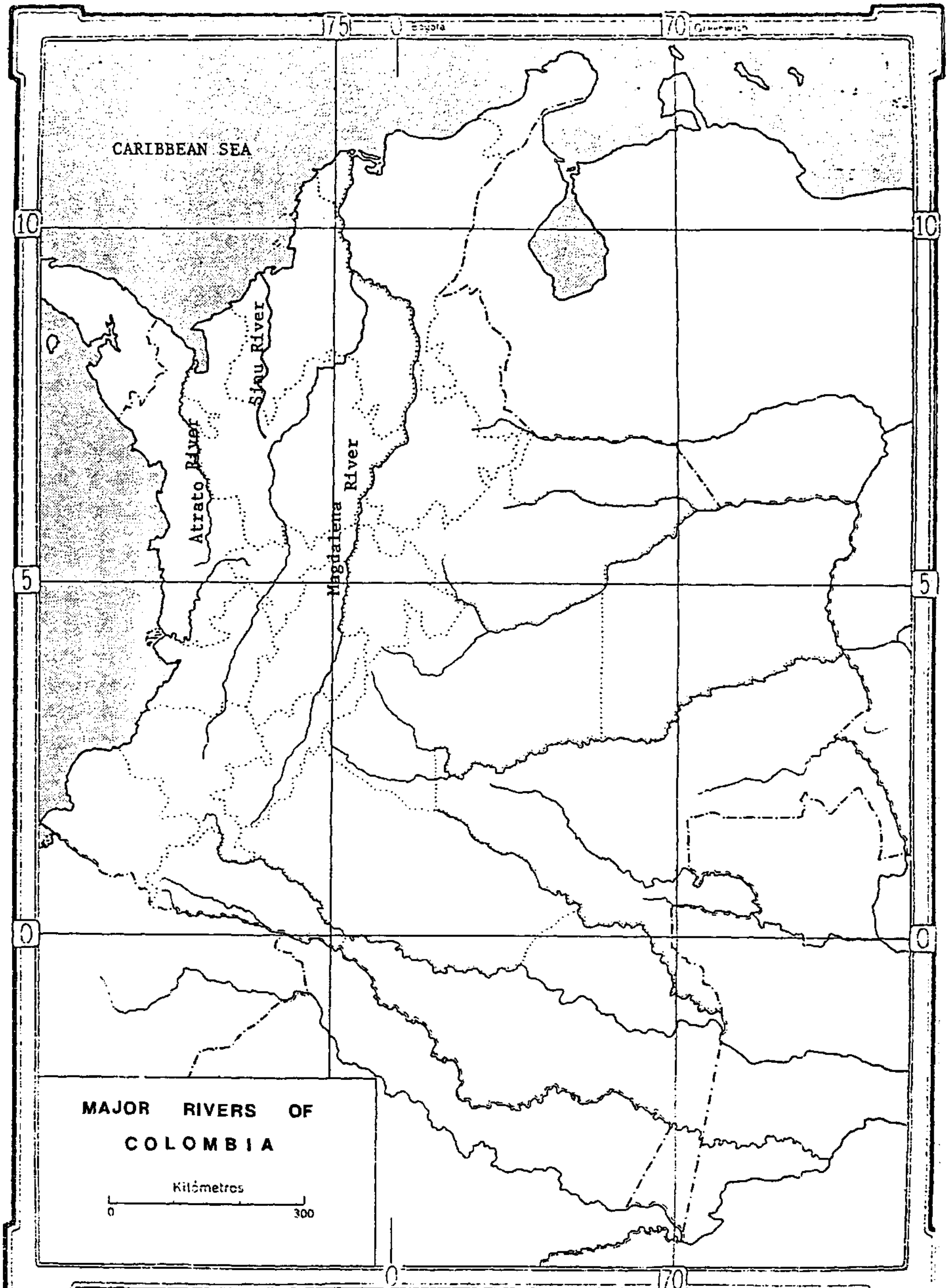
Main Rivers:

(i) Grande de Matagalpa - total length 418 km.

(ii) Coco - total length 433 km.

Guatemala

Guatemala has an area of 108,889 km^2 with a coastline along the


75
0 Bogotá
70 Greenwich
CARIBBEAN SEA
10
Sinu River
Atrato River
Magdalena River
5
0
MAJOR RIVERS OF COLOMBIA
Kilómetres
0
300
0
70

Caribbean of 110 km. The population is 5.3 million of which about 1 million live in Guatemala City.

The main river entering the Caribbean is the Motagua with a total length of about 400 km.

Panama

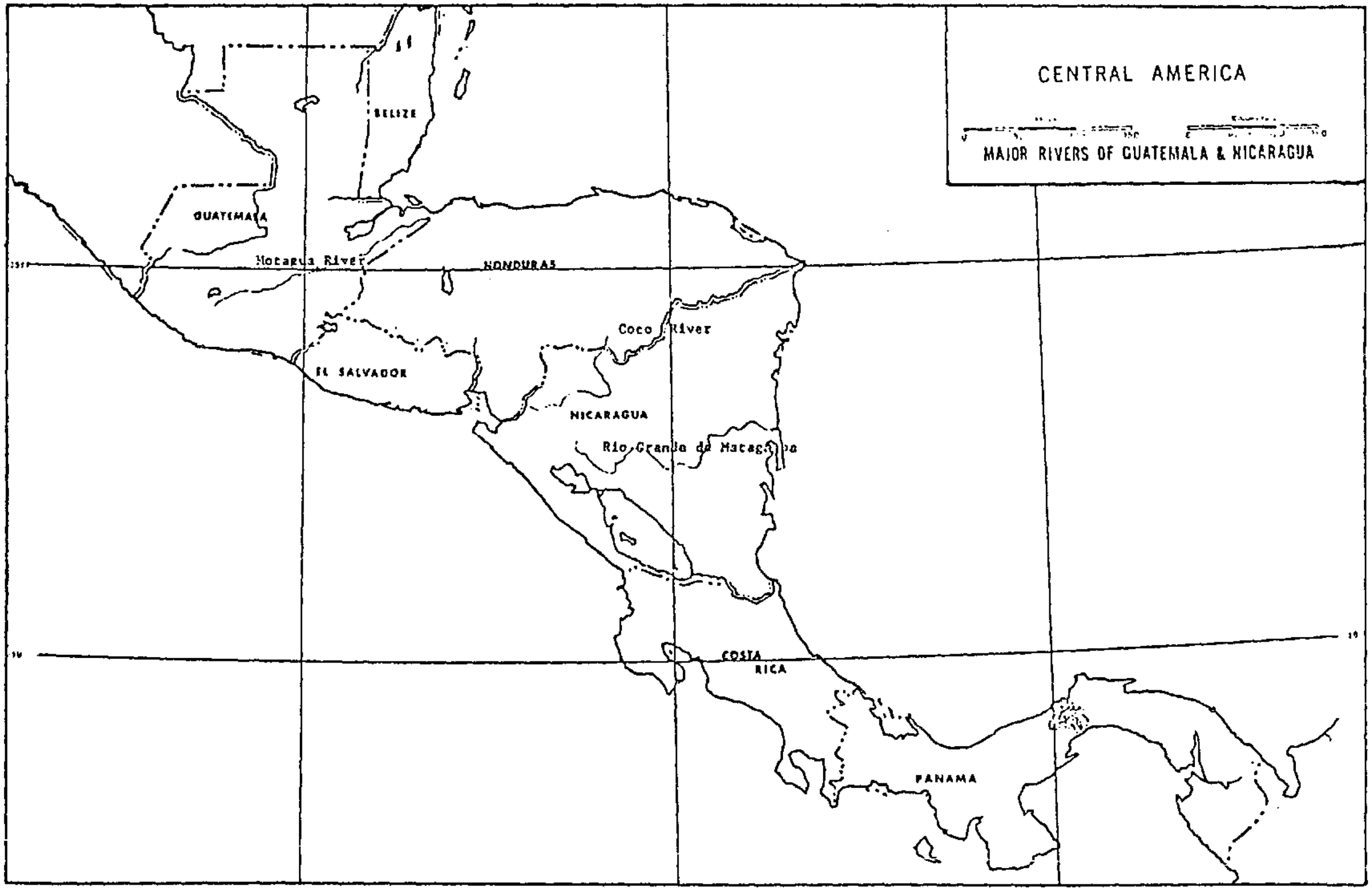
Panama has an area of 75,835 km^2 and the population is about 1.5 million (1970).

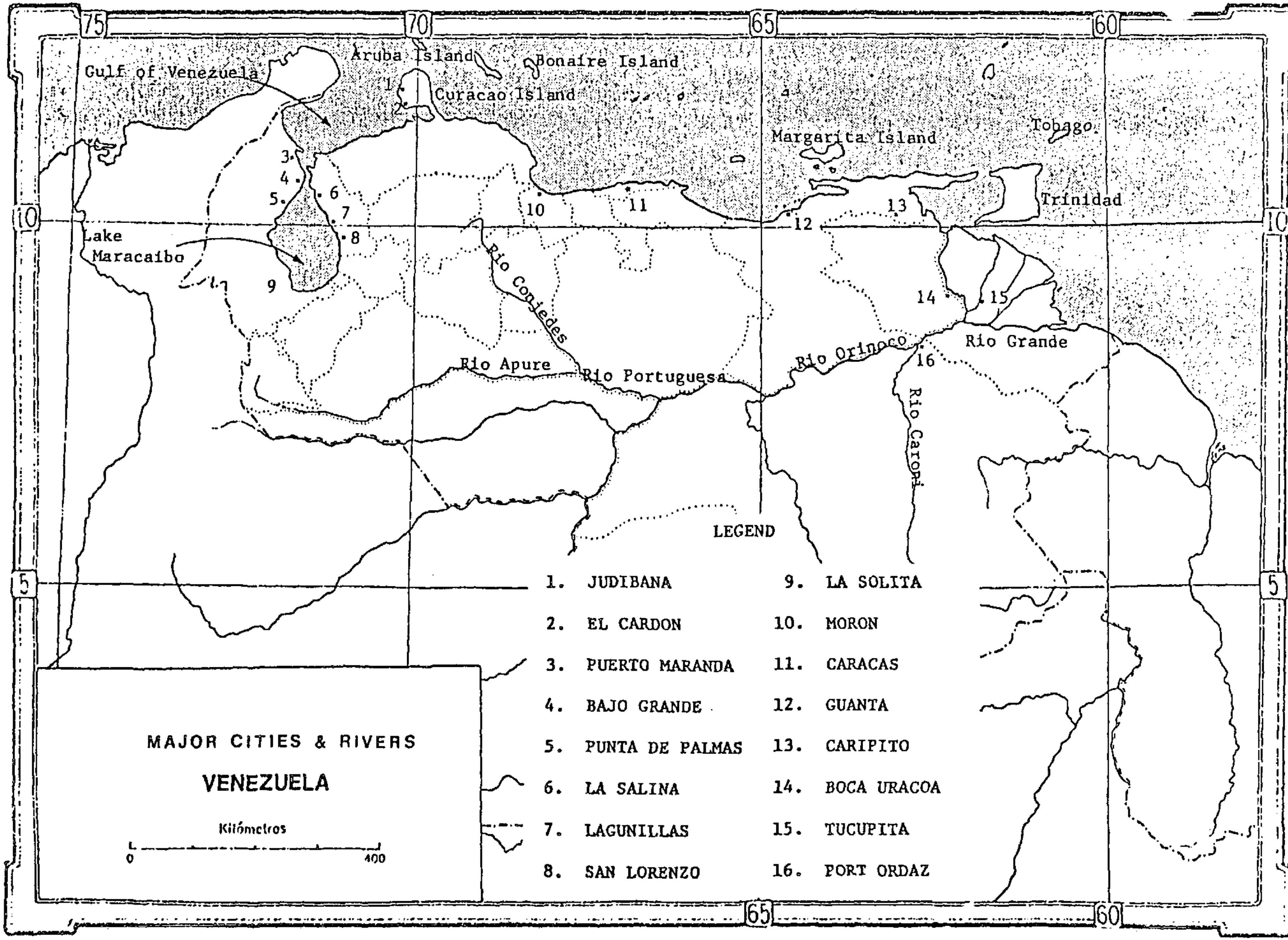
Venezuela

Venezuela has an area of 901,500 km^2 and a population of 11,990 miilion (1978). The capital is Caracas.

Main River:

(i) Orinoco and tributaries - area 950,000 km^2.


CENTRAL AMERICA
MAJOR RIVERS OF GUATEMALA & NICARAGUA
BELIZE
GUATEMALA
Motagua River
HONDURAS
Coco River
EL SALVADOR
NICARAGUA
Rio Grande de
COSTA RICA
PANAMA


75
70
65
60
10
5
Aruba Island
Bonaire Island
Curacao Island
Gulf of Venezuela
Margarita Island
Tobago
Trinidad
Lake Maracaibo
Rio Cojedes
Rio Apure
Rio Portuguesa
Rio Orinoco
Rio Grande
Rio Caroni
MAJOR CITIES & RIVERS
VENEZUELA
Kilómetros
0
400
LEGEND
1. JUDIBANA
2. EL CARDON
3. PUERTO MARANDA
4. BAJO GRANDE
5. PUNTA DE PALMAS
6. LA SALINA
7. LAGUNILLAS
8. SAN LORENZO
9. LA SOLITA
10. MORON
11. CARACAS
12. GUANTA
13. CARIPITO
14. BOCA URACOA
15. TUCUPITA
16. PORT ORDAZ

Oceanography of the Wider Caribbean Area

The tides and currents typically associated with the region are discussed.

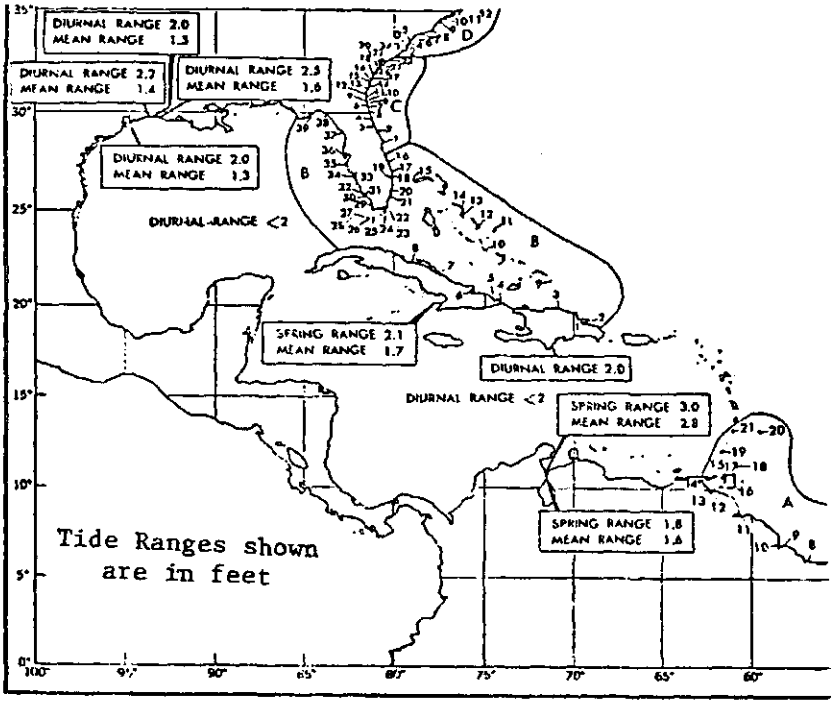
Tides in the Region

Although the tide is principally diurnal throughout the wider Caribbean, there does exist a mixed tide period. The diurnal tide range is generally less than .75 meter (2.5 feet) except on the east coast of Florida, on the north shore of Cuba, the Bahama Islands and in the Atlantic. Figure 2-2 shows the tide ranges for many locations scattered throughout the area. Included are the names of tide stations, their locations, mean heights and maximum tide or spring tides. Figure 2-3 shows the locations of tide curves that are typical of the indicated areas of interest. These tide curves are included as Figure 2-4. The numbers that appear in Figure 2-3 are matched with the same numbers on Figure 2-4.

Surface Currents in the Region

There is a continuous east to west circulation pattern in the Caribbean Sea, with water entering the system from the Atlantic near Tobago & Trinidad and exiting at the Yucatan Straits. The current picture of the Gulf of Mexico is more complex. Water enters the system at the Yucatan Strait and exits at the Florida Strait. The flow within the gulf is complex and varies with the time of year. Major components are counter current geyers in the western Gulf and several smaller geyers in the Campeche Bay area and to the west of Florida.

The reader is referred to the detailed diagrams for the Caribbean and North Atlantic shown in Figure or to the Pilot Charts for the Caribbean and Gulf areas for more detailed information.



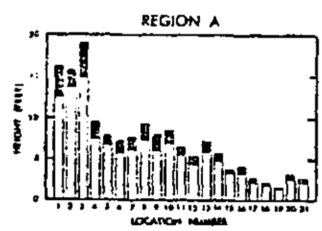
NAMES OF TIDE STATIONS FOR RANGE CHART
(FROM USC & GS TIDE TABLES, 1964)

REGION A

- POINT PEDRERA, AMAZON RIVER
- 2. ILHA DO BRIGUE, AMAZON RIVER
- 3. ILHA DE MARACA ANCHORAGE
- 4. CAPE CACHIPOUR
- 5. CAYENNE
- 6. ILES DU SALUT
- 7. SURINAME RIVER ENTRANCE
- 8. NICKERIE RIVER
- 9. GEORGETOWN
- 10. PARIKA, ESSEQUIBO RIVER
- 11. RIO ORINOCO ENTRANCE, ISLA TERCERA
- 12. RIO PEDERNALES ENTRANCE
- 13. PUNTA GORDA, RIO SAN JUAN
- 14. MATURIN BAR, CHANNEL ENTRANCE
- 15. PUERTO DE HIERRO
- 16. GUAYAGUAYARE BAY
- 17. CARENAGE BAY
- 18. TOBAGO
- 19. GRENADA
- 20. BARBADOS
- 21. ST. VINCENT, KINGSTOWN

REGION B

- 1. SANCHEZ, SAMANA BAY
- 2. SAMANA, SAMANA BAY
- 3. PUERTO PLATA
- 4. PUNTA MAISI
- 5. BARACOA
- 6. ANTILLA, NIPE BAY
- 7. NUEVITAS, NUEVITAS BAY
- 8. ISABELA DE SAGUA
- 9. HAWKS NEST ANCHORAGE, TURKS ISLANDS
- 10. CLARENCE HARBOR, LONG ISLAND
- 11. SAN SALVADOR
- 12. THE BIGHT, CAT ISLAND
- 13. ELEUTHERA ISLAND, EAST COAST
- 14. ELEUTHERA ISLAND, WEST COAST
- 15. MEMORY ROCK
- 16. FORT PIERCE INLET (BREAKWATER)
- 17. SEWALL POINT, ST. LUCIE RIVER
- 18. PORT OF PALM BEACH, LAKE WORTH
- 19. PALM BEACH (OCEAN)
- 20. ANDREWS AVENUE BRIDGE, NEW RIVER
- 21. MIAMI BEACH
- 22. FOWEY ROCKS LIGHT
- 23. ADAMS KEY, BISCAYNE BAY
- 24. MOSQUITO BANK
- 25. BOOT KEY HARBOR, VACA KEY
- 26. PALOMA KEY, NORTH SIDE
- 27. NORTHWEST CHANNEL (NORTH END)
- 28. MARQUESAS KEYS
- 29. SHARK RIVER ENTRANCE
- 30. EVERGLADES, BARRON RIVER
- 31. COON KEY, GULLIVAN BAY
- 32. MARCO, BIG MARCO RIVER
- 33. NAPLES (OUTER COAST)
- 34. PORT BOCA GRANDE, CHARLOTTE HARBOR
- 35. SARASOTA, SARASOTA BAY
- 36. SAFETY HARBOR, OLD TAMPA BAY
- 37. WITHLACOOCHEE RIVER ENTRANCE
- 38. BALD POINT, OCHLOCKONEE BAY
- 39. DOG ISLAND, WEST END



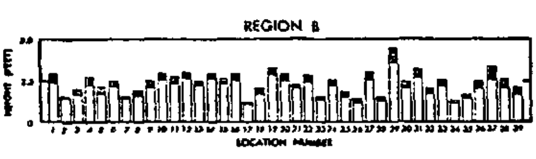


FIGURE 2-2: Tide Stations and locations in the wider Caribbean Region.

Source: Oceanographic Atlas of the North Atlantic Coast: Section I (1965)

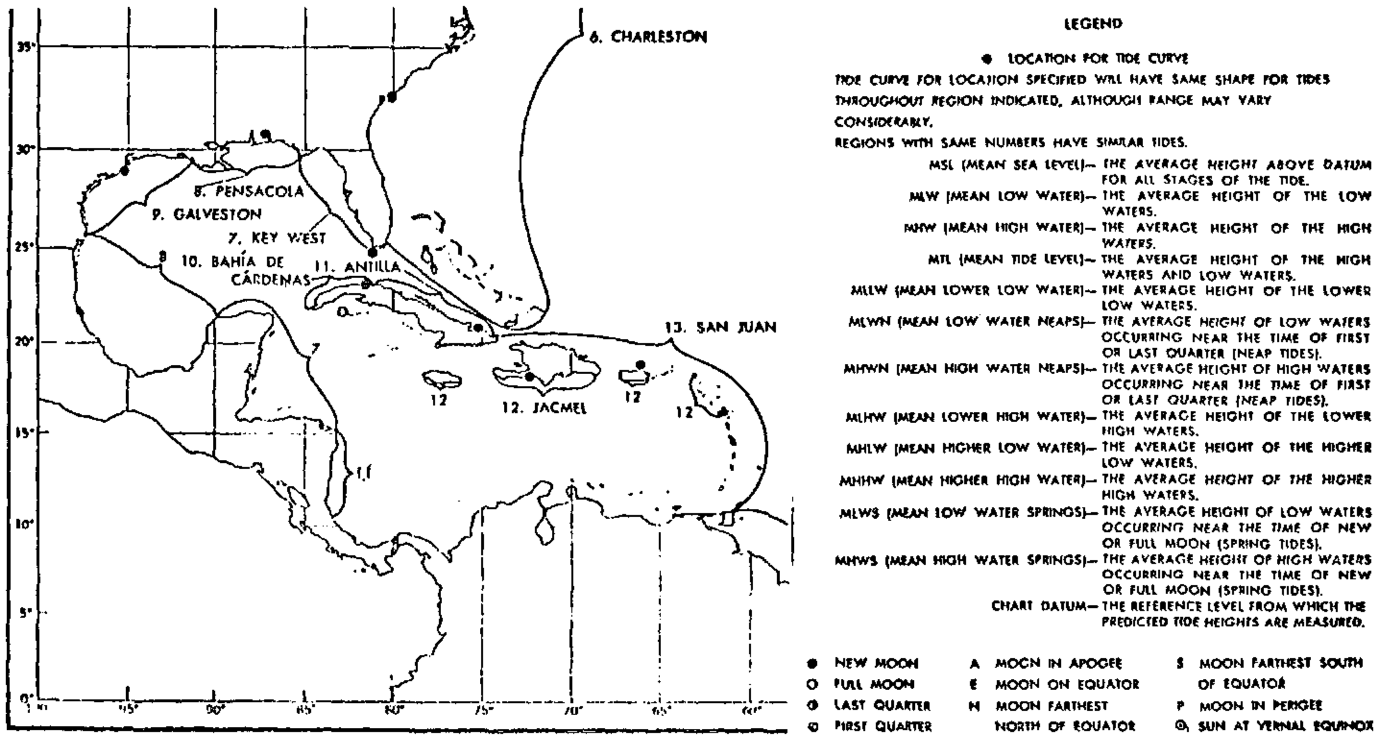
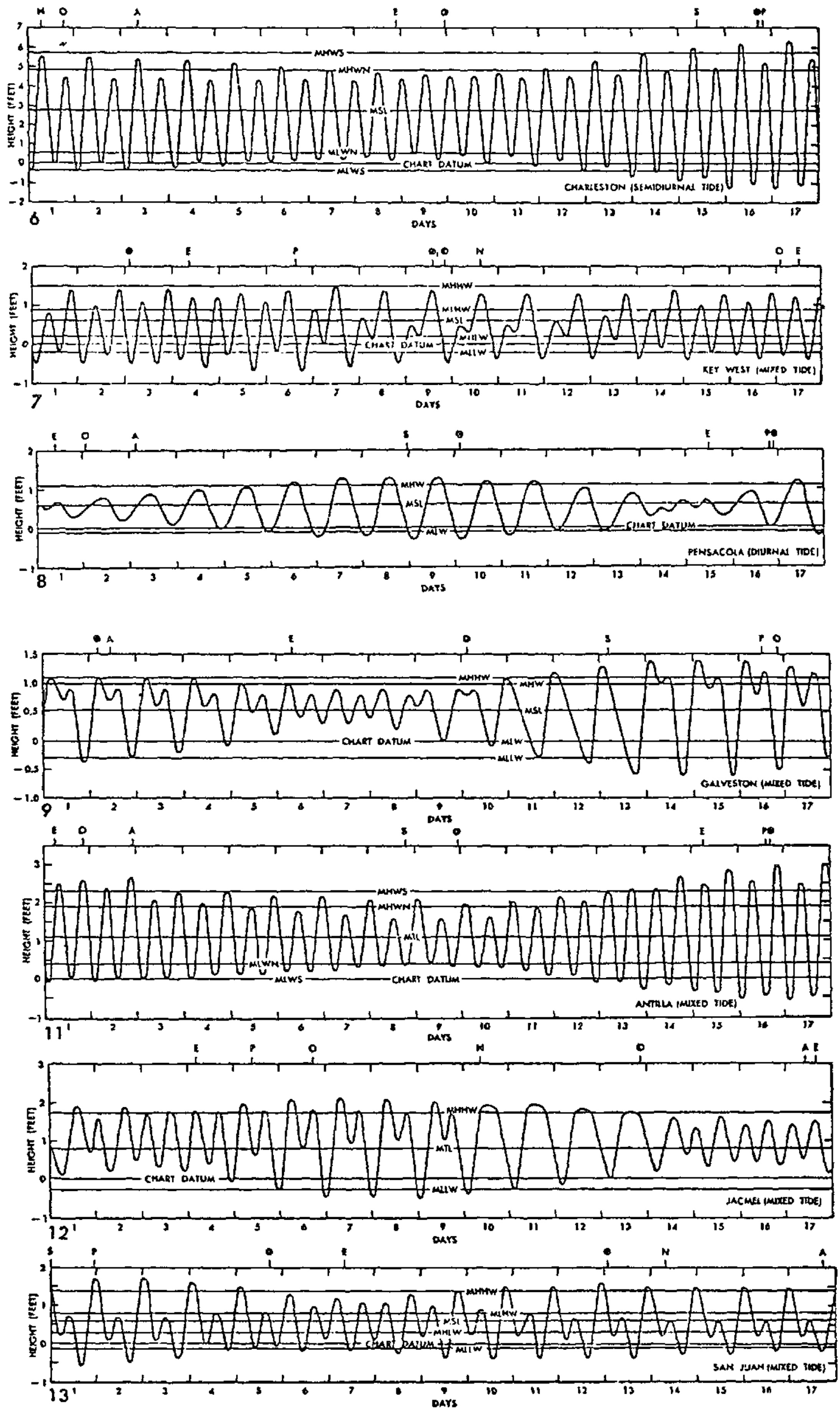


FIGURE 2-3: Typical Locations of Predominant Tide Curves for the Wider Caribbean Region

Source: Oceanographic Atlas of the North Atlantic Coast: Section I (1965)

FIGURE 2-4: Typical Tide Curves for Wider Caribbean Region.

Source: Oceanographic Atlas of the North Atlantic Coast: Section I (1965)



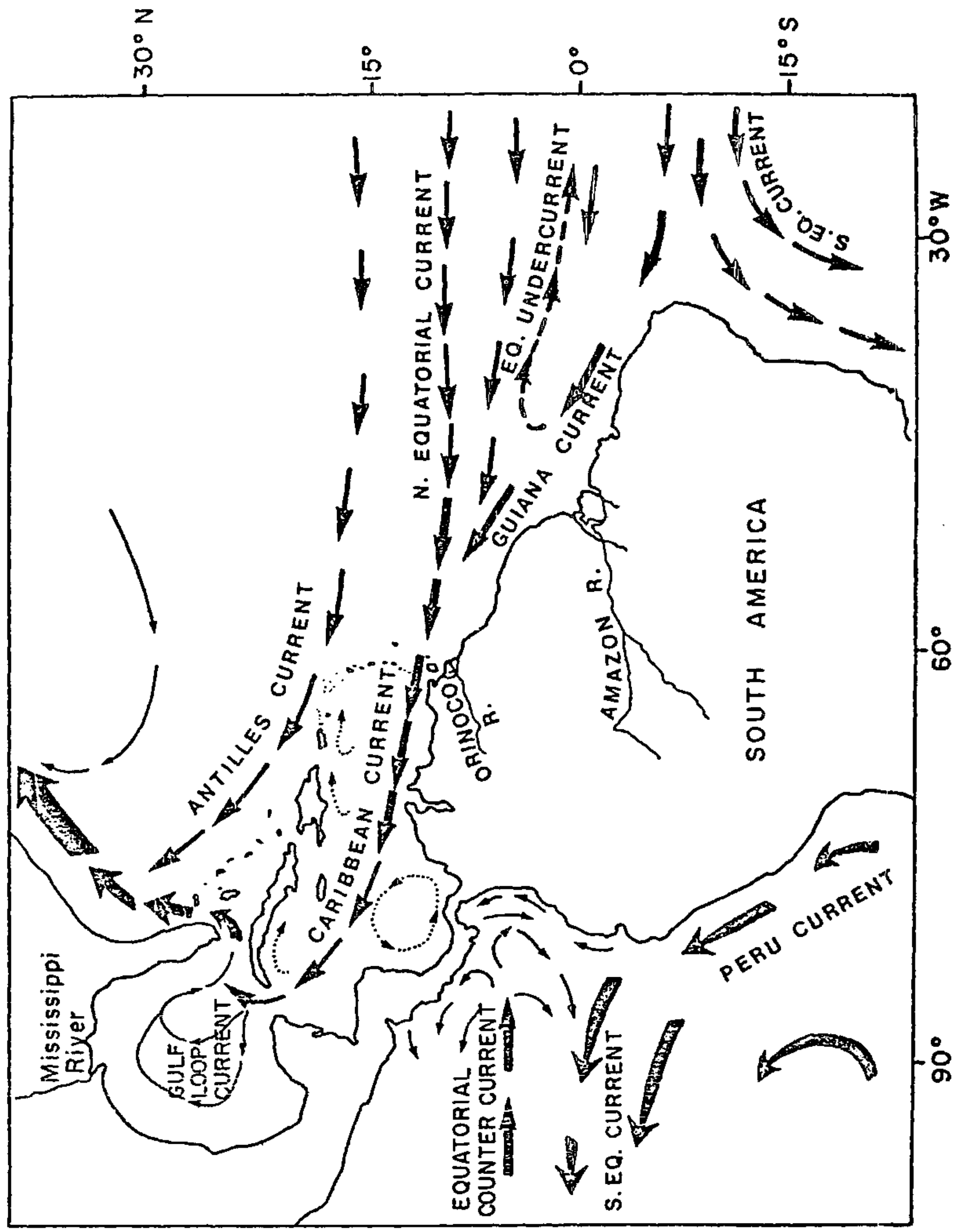


FIGURE 2-5

Schematic representation of surface currents in and adjacent to the Caribbean Sea and Gulf of Mexico, as well as the northwest coast of South America.

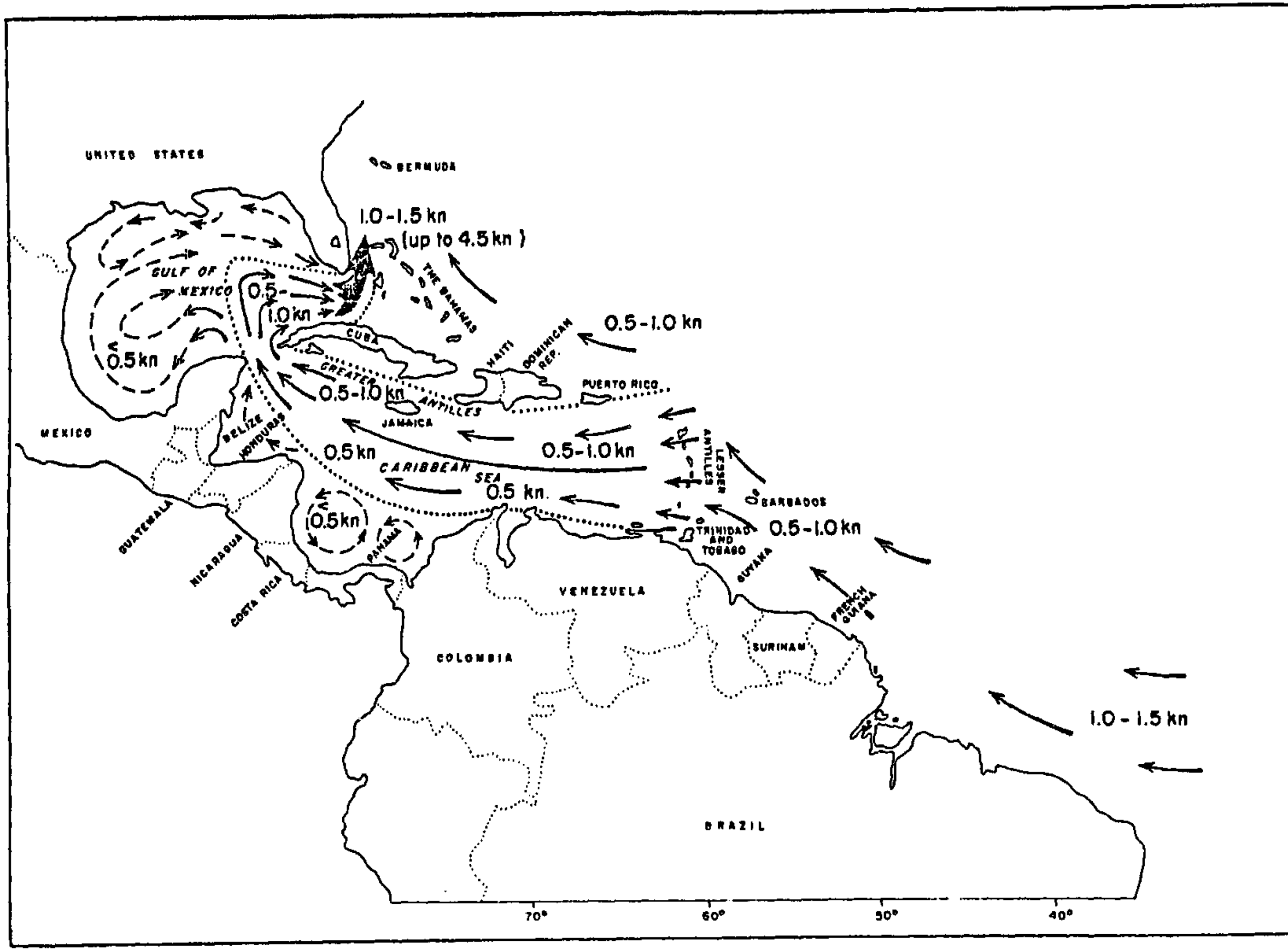
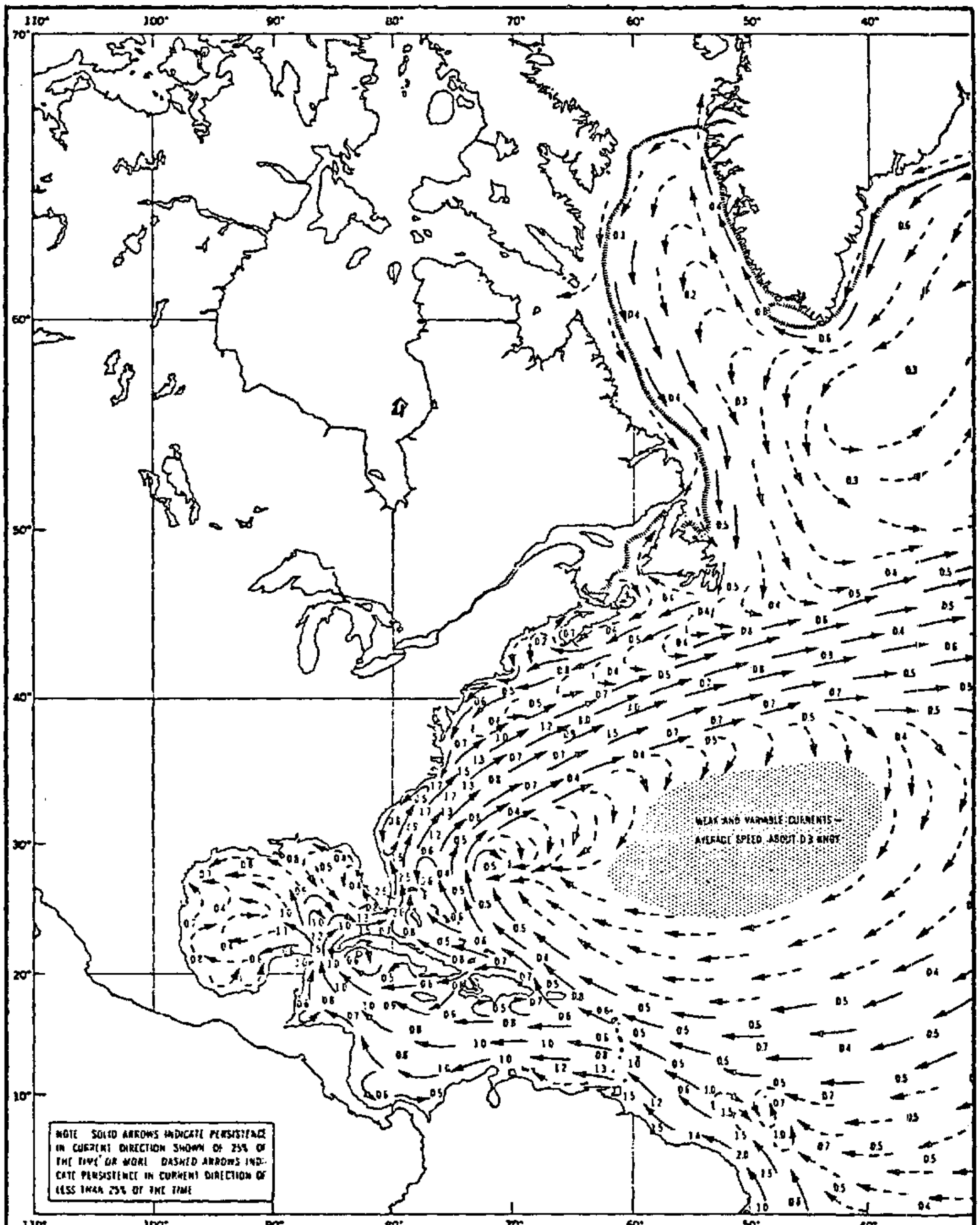


FIGURE 2-6 General water movements

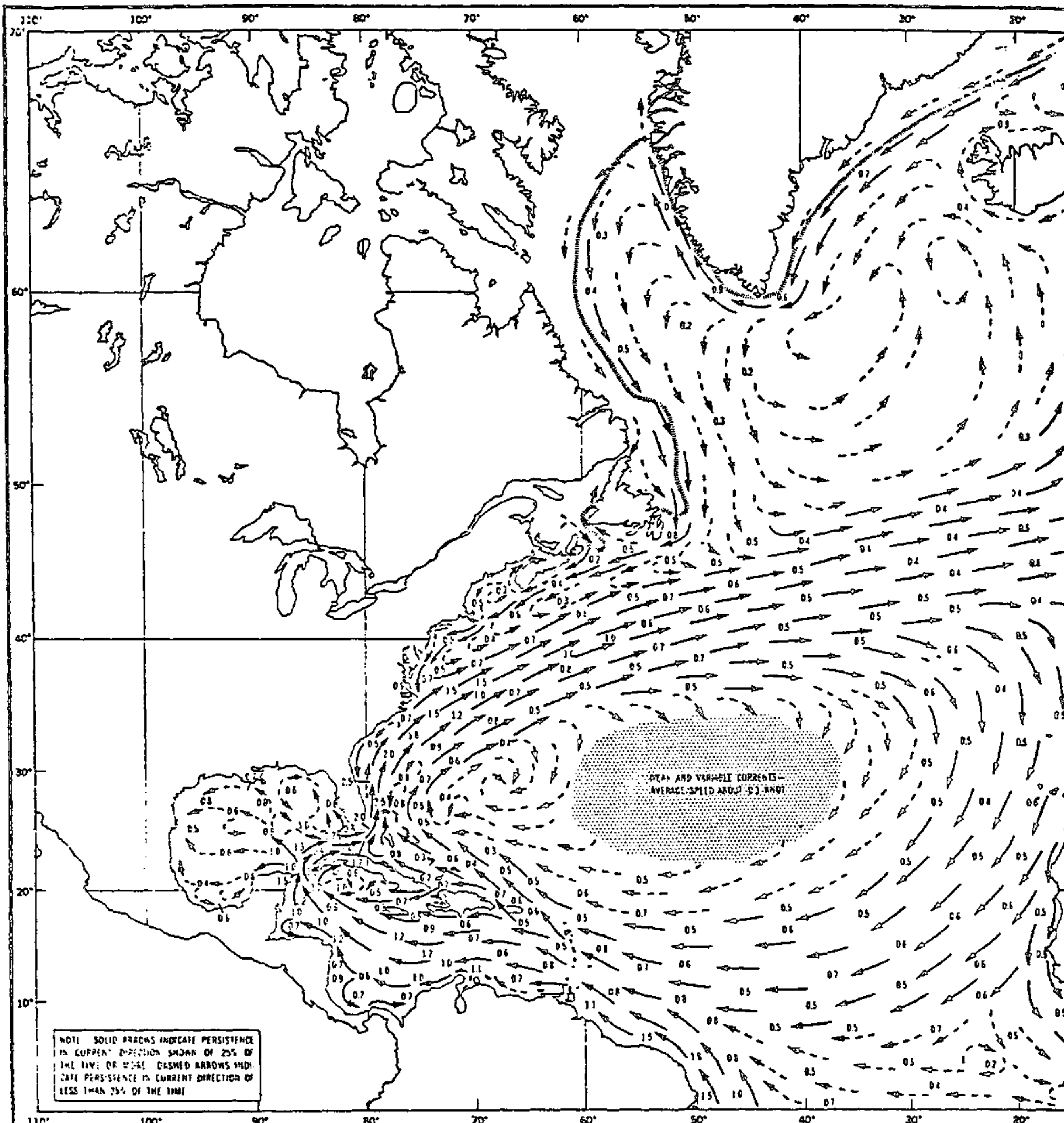
SURFACE CURRENTS



Average surface currents in January.

FIGURE 2-7

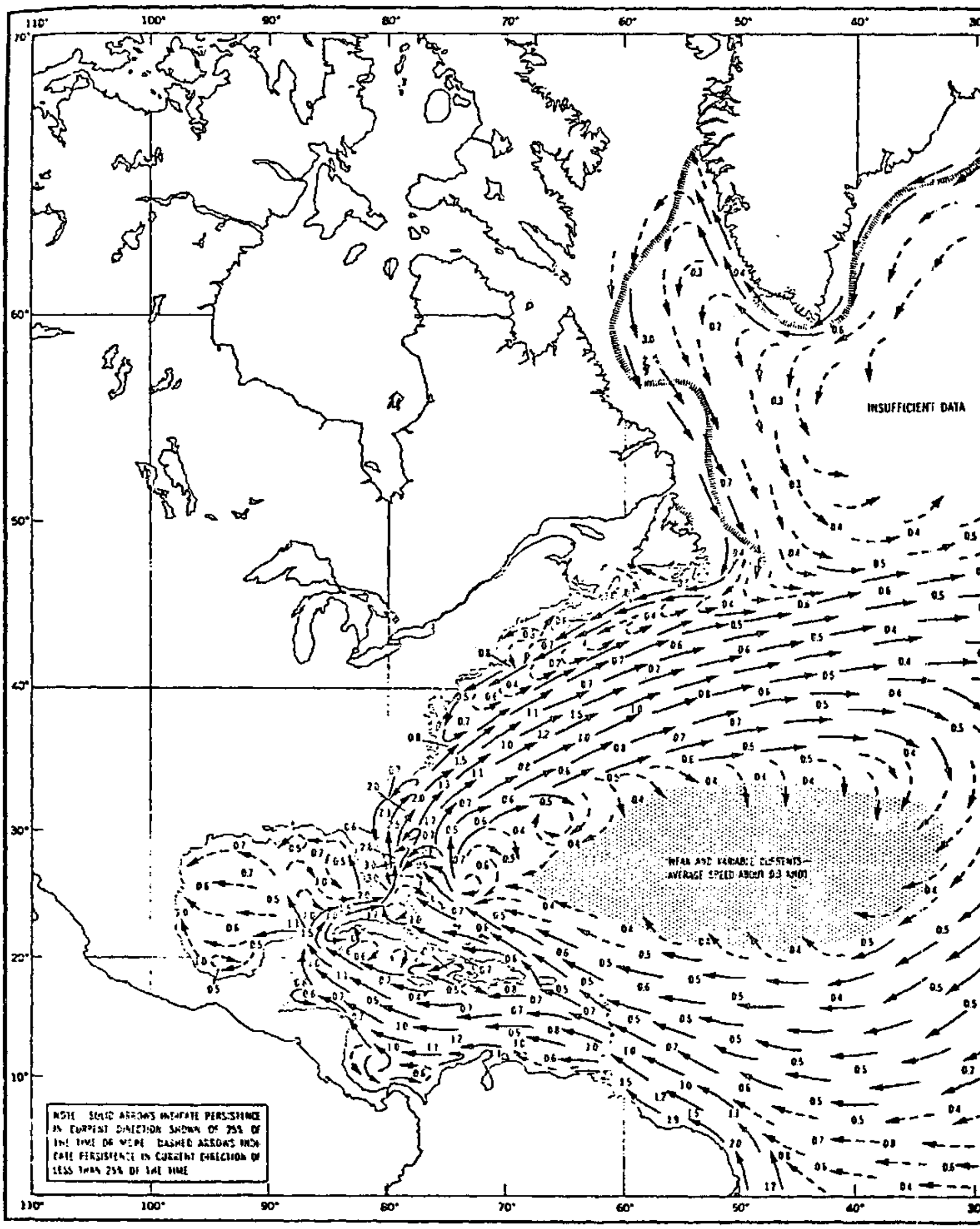
SURFACE CURRENTS



Average surface currents in February.

FIGURE 2-7 (continued)

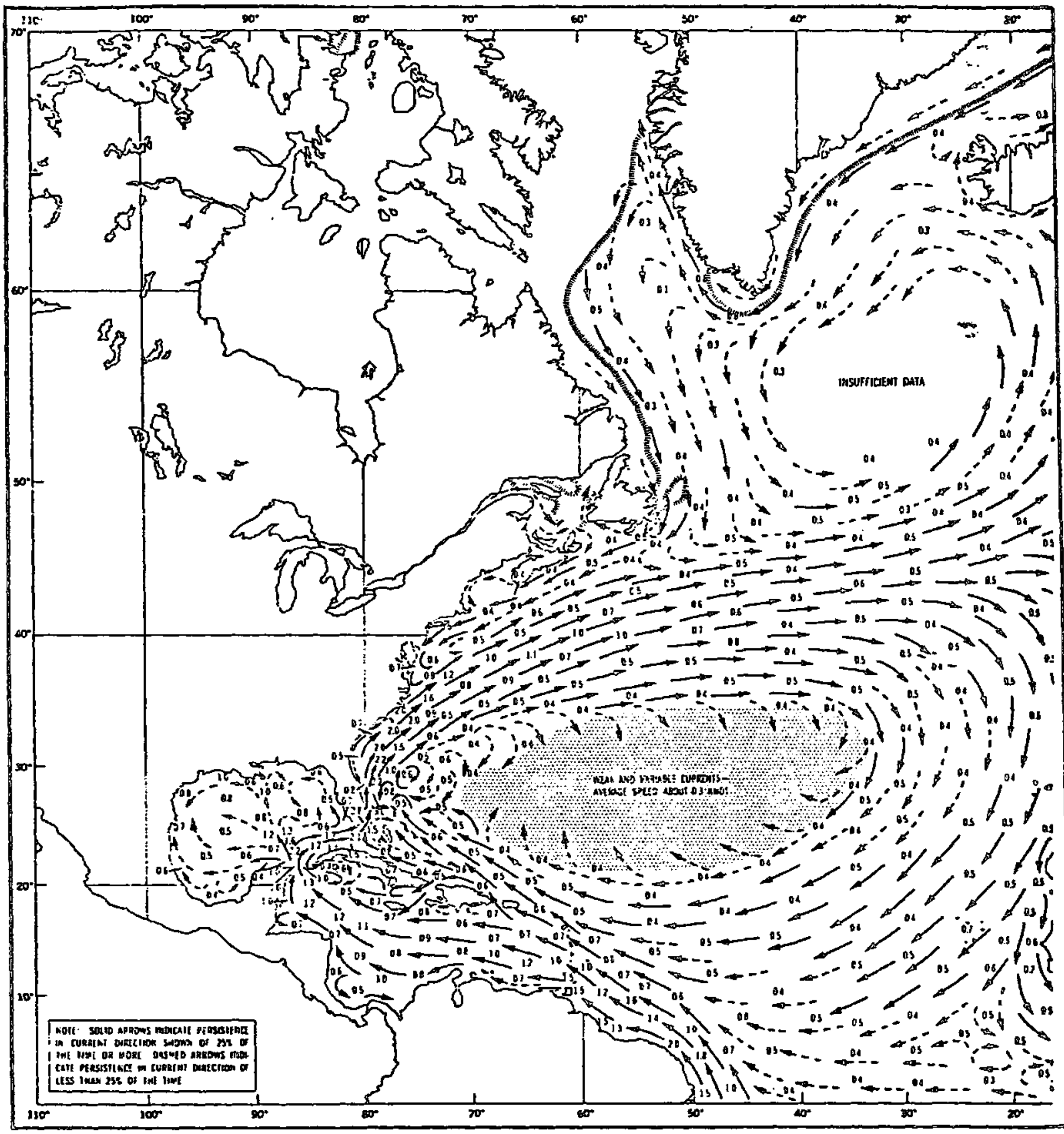
SURFACE CURRENTS



Average surface currents in March.

FIGURE 2-7 (continued)

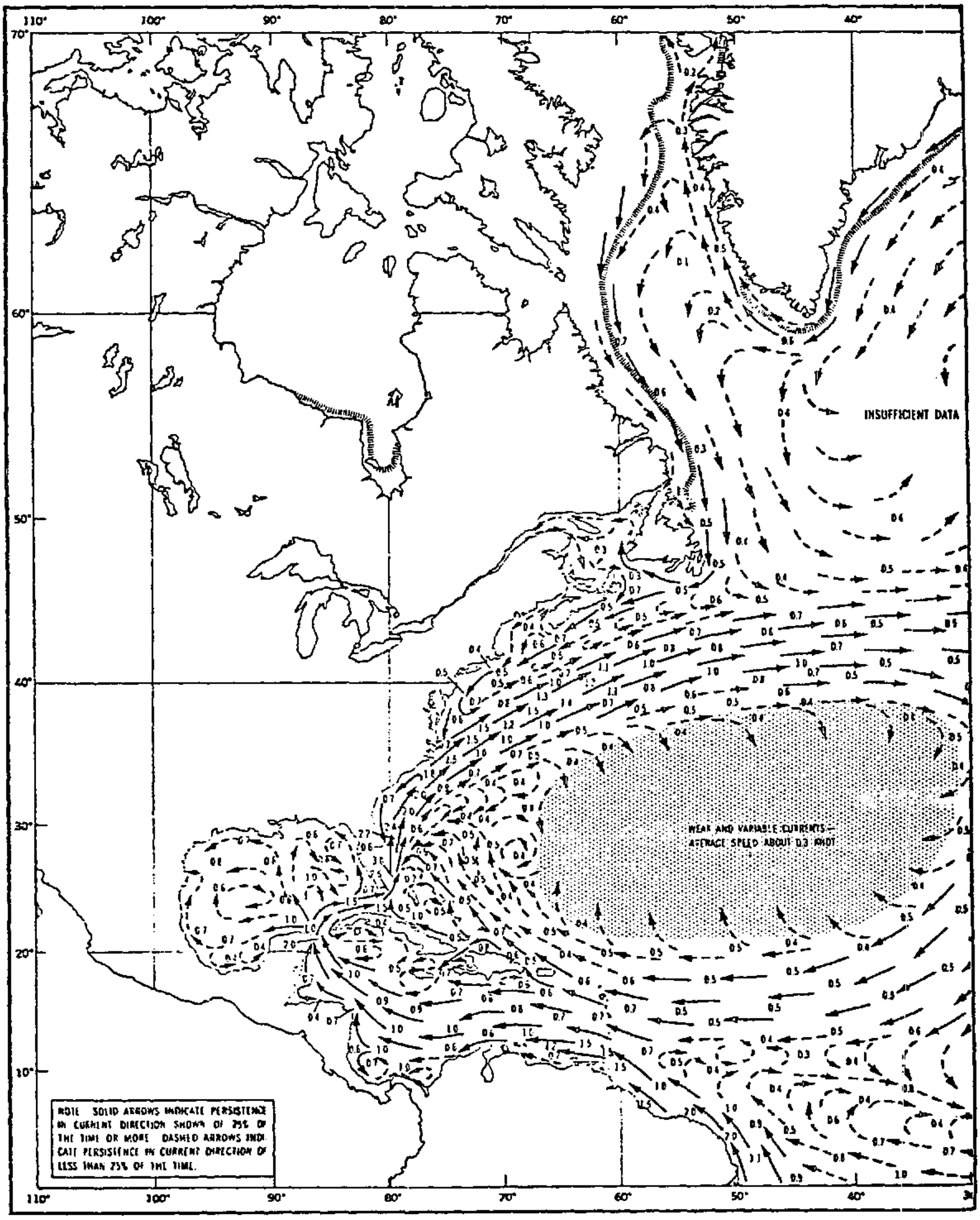
SURFACE CURRENTS



Average surface currents in April.

FIGURE 2-7 (continued)

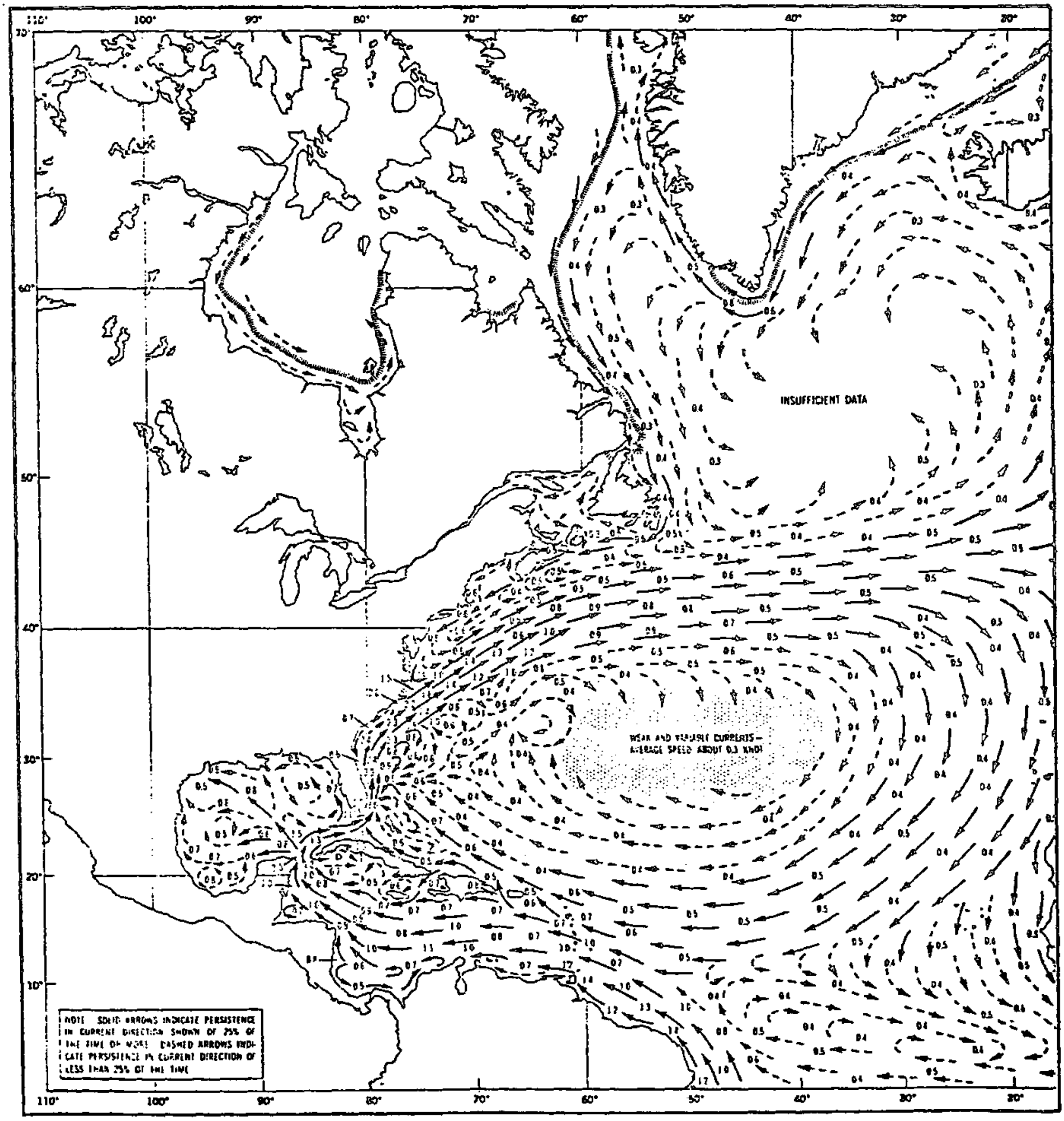
SURFACE CURRENTS



Average surface currents in May.

FIGURE 2-7 (continued)

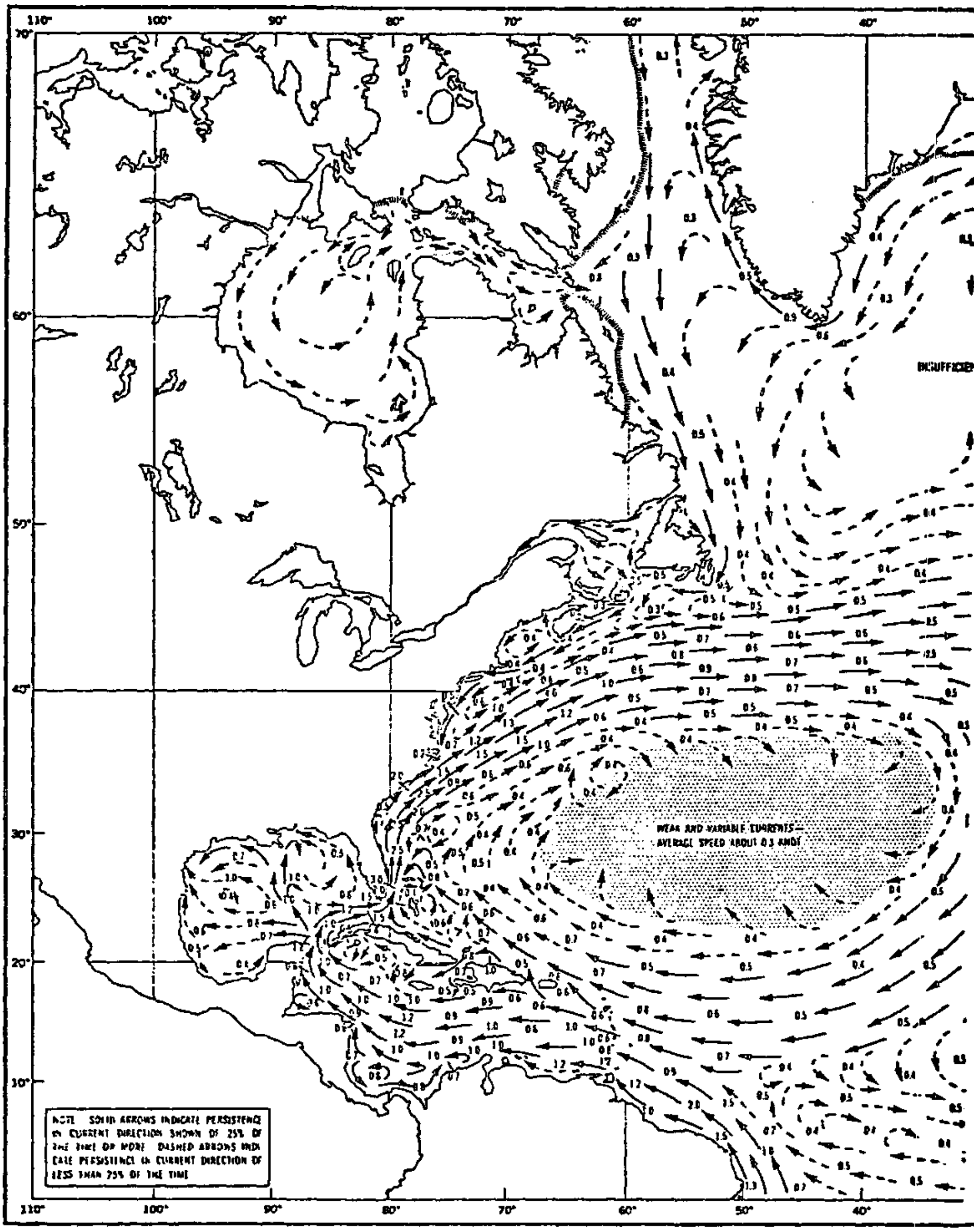
SURFACE CURRENTS



Average surface currents in June.

FIGURE 2-7 (continued)

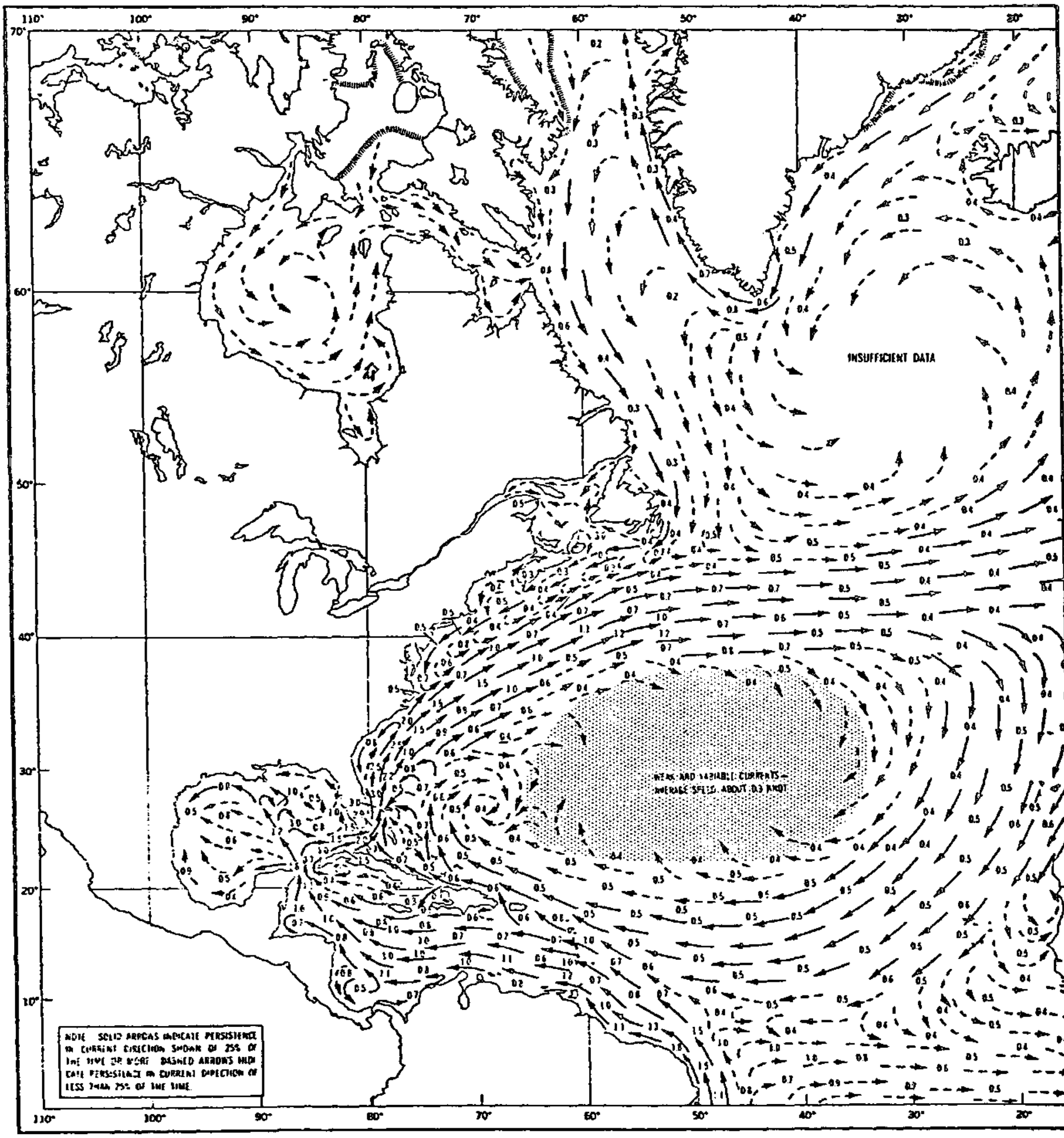
SURFACE CURRENTS



Average surface currents in July.

FIGURE 2-7 (continued)

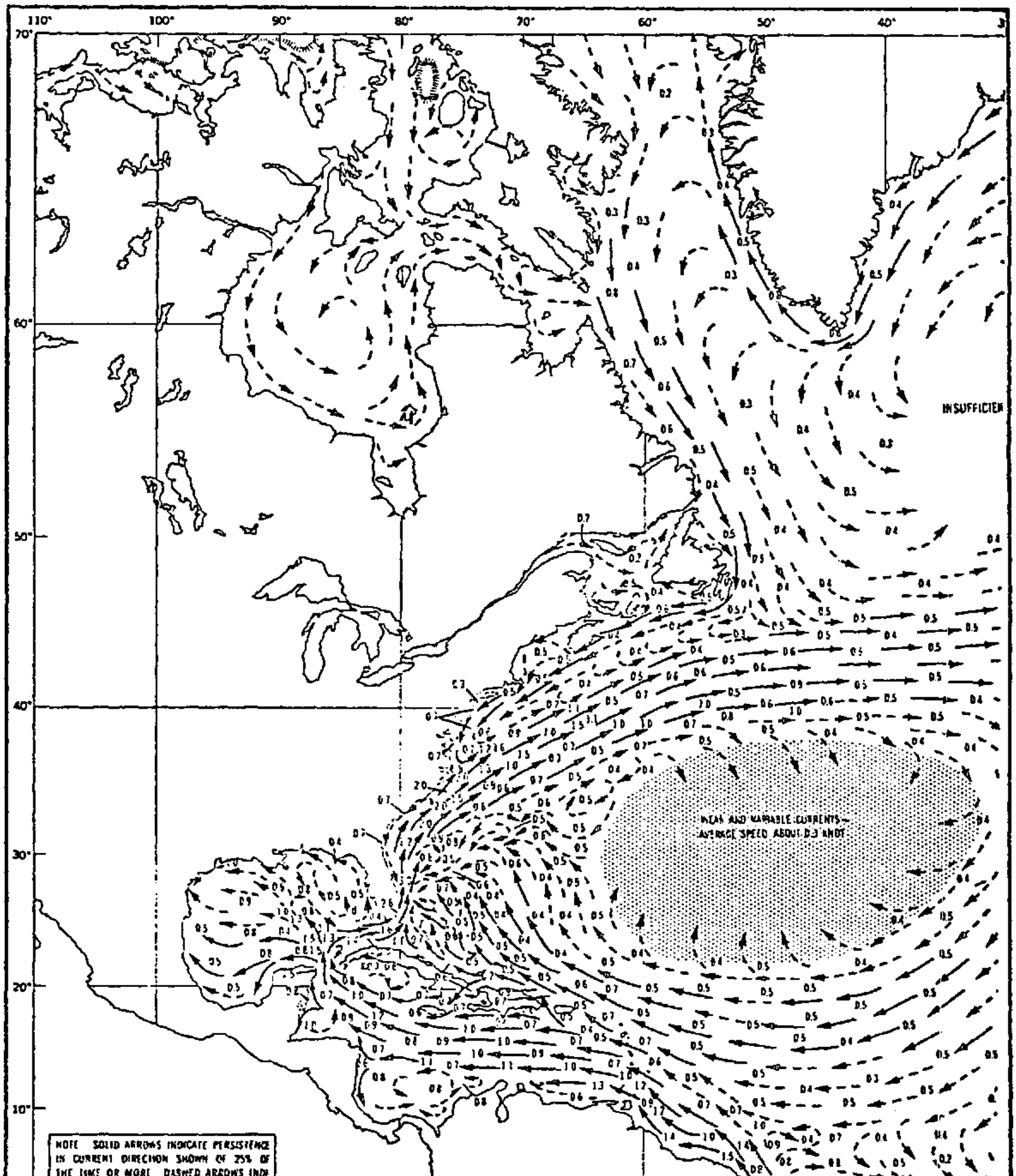
SURFACE CURRENTS



Average surface currents in August.

FIGURE 2-7 (continued)

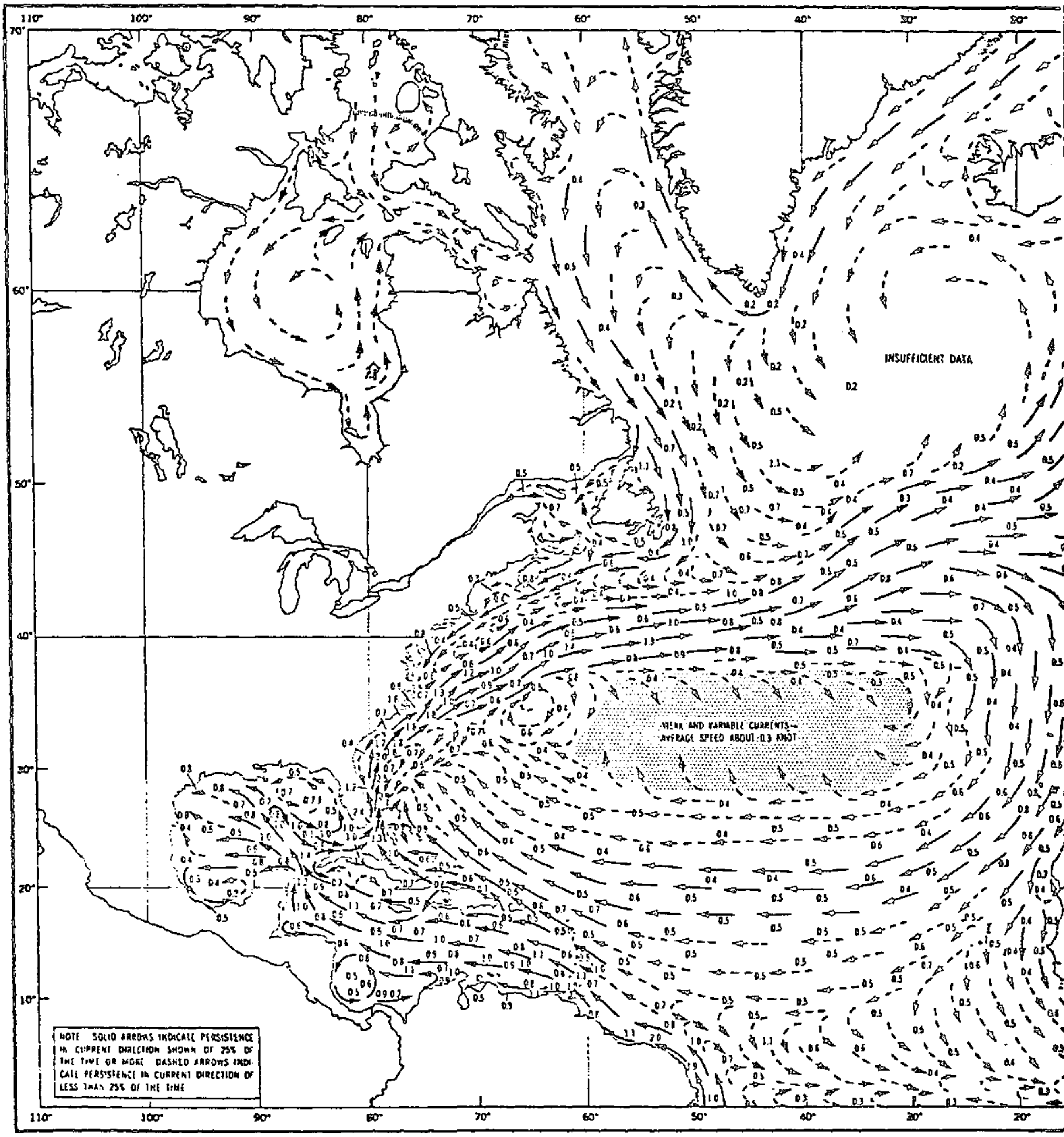
SURFACE CURRENTS



Average surface currents in September.

FIGURE 2-7 (continued)

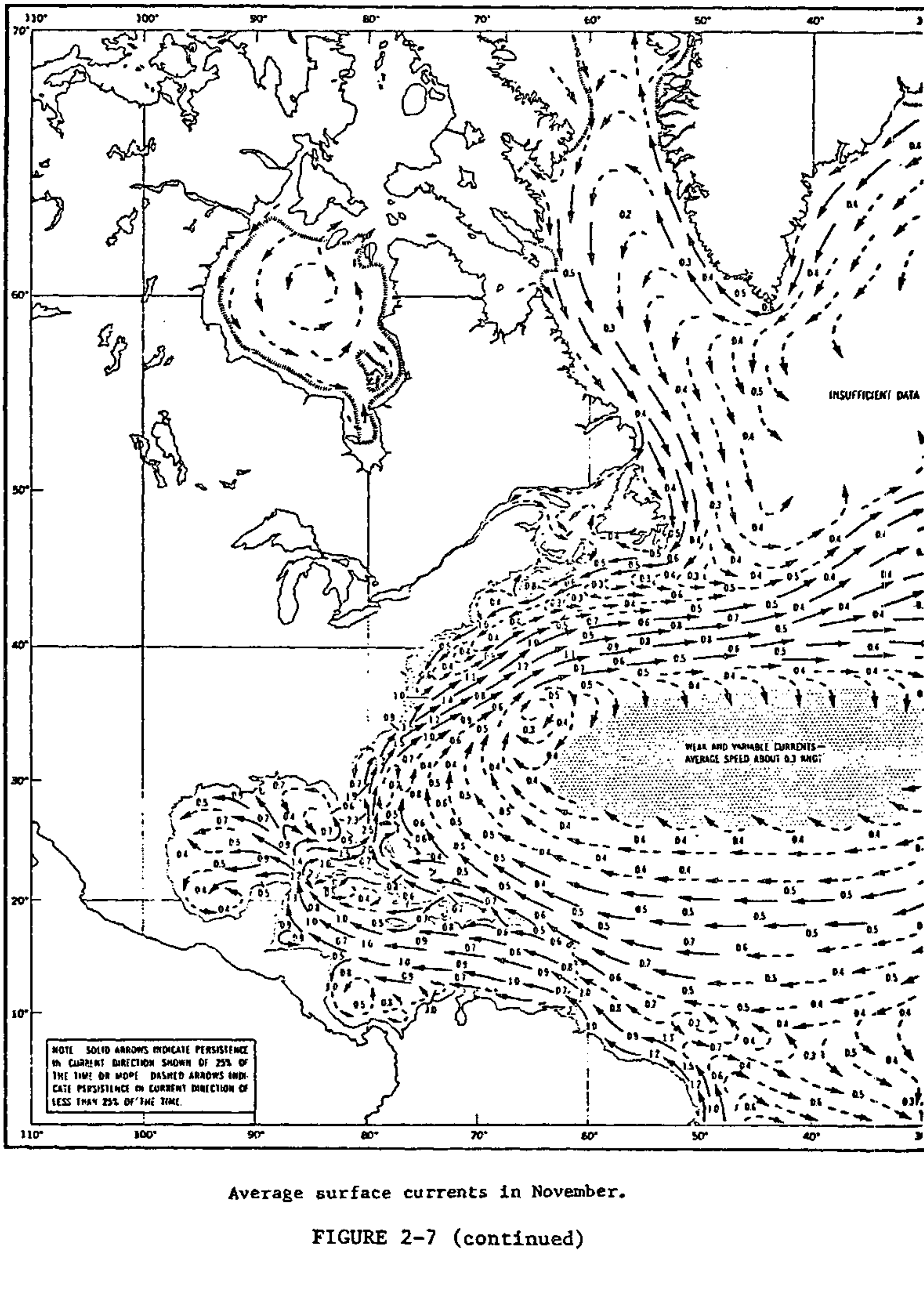
SURFACE CURRENTS



Average surface currents in October.

FIGURE 2-7 (continued)

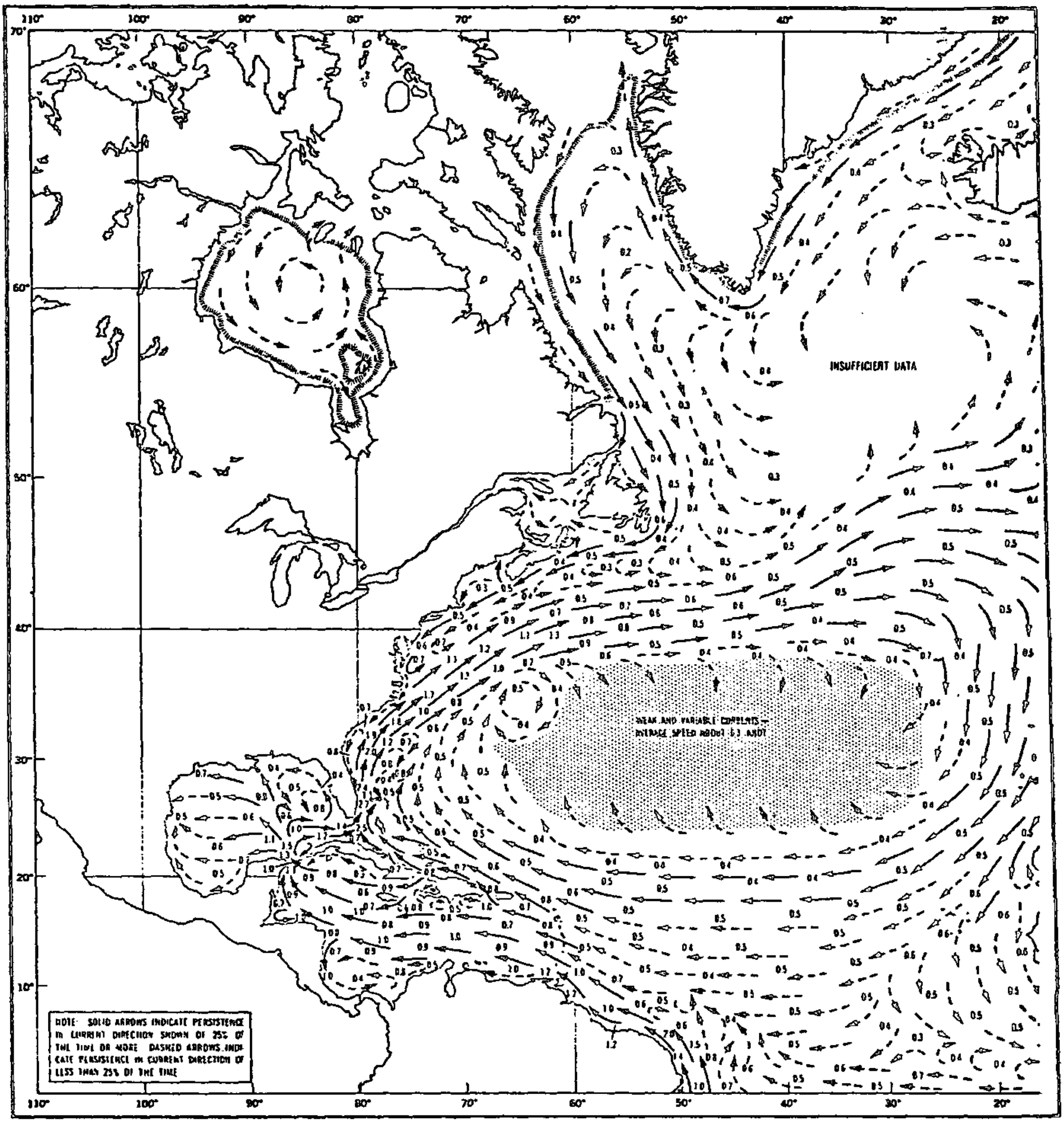
SURFACE CURRENTS



Average surface currents in November.

FIGURE 2-7 (continued)

SURFACE CURRENTS



Average surface currents in December.

FIGURE 2-7 (continued)

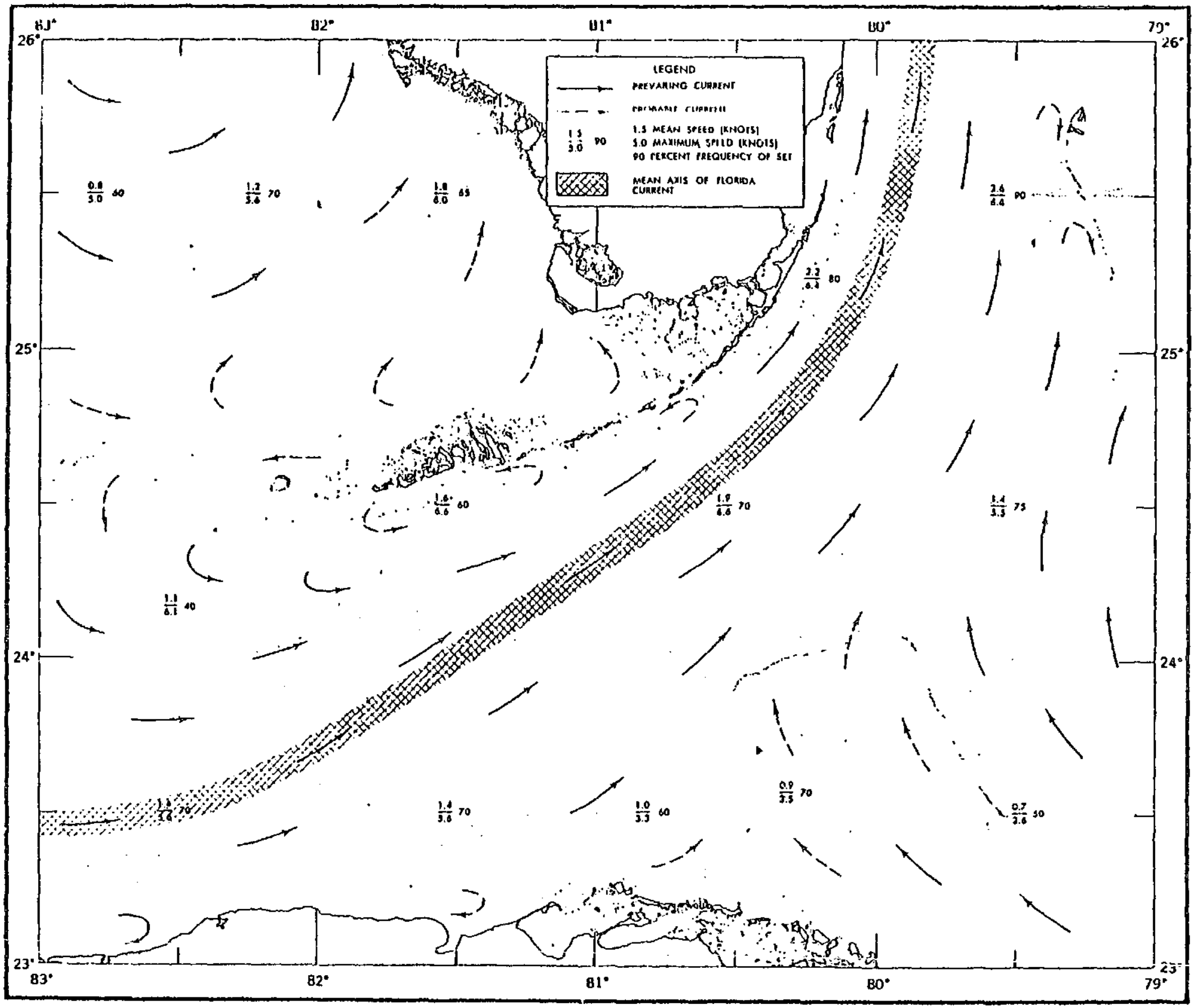


FIGURE 2-8 (continued) SURFACE CURRENTS, STRAITS OF FLORIDA

Source: Oceanographic Atlas of the North Atlantic
Section I (1965) Public #700

Meteorology in the Region

Typical surface winds and temperatures are presented for the region. Wind speed, direction and duration or intensity, are important parameters associated with movement of the oil and many of the spreading and decaying functions are temperature dependent.

Sea Surface Winds

Surface winds influence the wave height and surface currents for a given area. Table 2-3 gives the sea description as described by Bascum. The wave height is listed as a function of wind velocity, assuming the wind direction and intensity are relatively constant. Typical wind roses for the Caribbean and Gulf of Mexico areas are shown in Figure 2-10 for January, March, July and December. Although all twelve months of data was available, inspection of each did not indicate any large variance of the rose patterns presented here. Figure 2-9 is a legend for the interpretation of these particular wind roses.

Generally speaking, the wind is from the eastern quadrant near the north coast of South America. About 40% of the time the wind is blowing from the northeast. In the northeastern part of the region the wind is often 15-20 knots or more. From the Virgin Islands, east to Cayman, the trade winds that blow from the north and east strongly effect currents as mentioned earlier. As a general rule, gales also blow from the same direction during the winter months. In this area, the sea adjacent to the south and west shores of these islands is usually rather calm. Trade winds blowing from the east to the west are very common throughout the entire region.

In terms of movement of oil, the expected contribution of wind speed to the currents at the water surface is about 3.5% of the wind speed. The surface current will tend to act in the same direction into which the

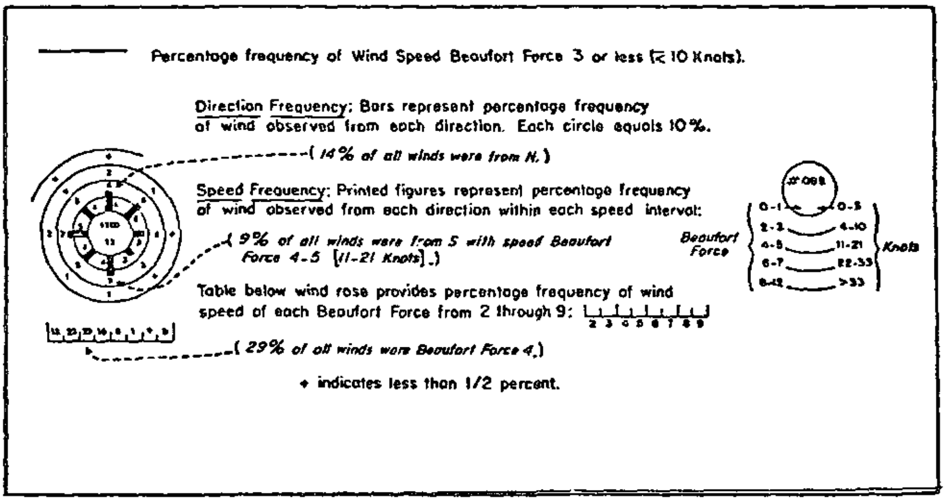
Table 2-3 Wind Scales and Sea Descriptions *

Beaufort Scales	Wind Velocity Knots	meters/ second	Description	Wave Heights Feet	Meters	State of Sea Code
1	1-3	0.6	Light air; ripples - no foam crests.	0	0	0
2	5	1.5	Light breeze; small wavelets, crests have glassy appearance and do not break.	0-1	0 -0.3	1
3	10	3.1	Gentle breeze; large wavelets, crests begin to break. Scattered whitecaps.	1-2	0.3-0.6	2
4	15	4.6	Moderate breeze; small waves becoming longer. Frequent whitecaps.	2-4	0.6-1.2	3
5	20	6.1	Fresh breeze; moderate waves taking a more pronounced long form; mainly whitecaps, some spray.	4-8	1.2-2.4	4
6	25	7.7	Strong breeze; large waves begin to form extensive whitecaps everywhere, some spray.	8-13	2.4-4.0	5
7	30	9	Moderate gale; sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	13-16	4 -5	5 1/2
8	40	12	Fresh gale; edges of crests break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.	16-20	5 -6	6
10	50	15	Whole gale. The surface of the sea takes on a white appearance. The rolling of the sea becomes heavy.	20-30	6 -9	7

*Source: Seadock Report

SURFACE WINDS

Figure 2-9



#2
Jan

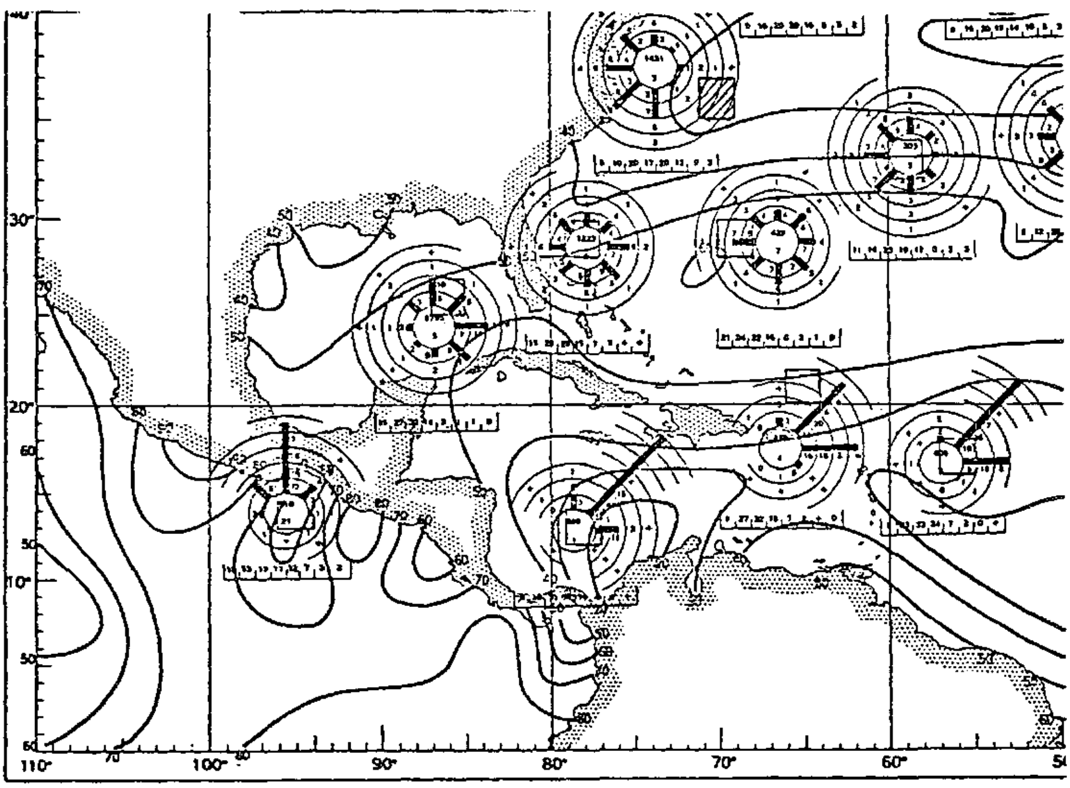
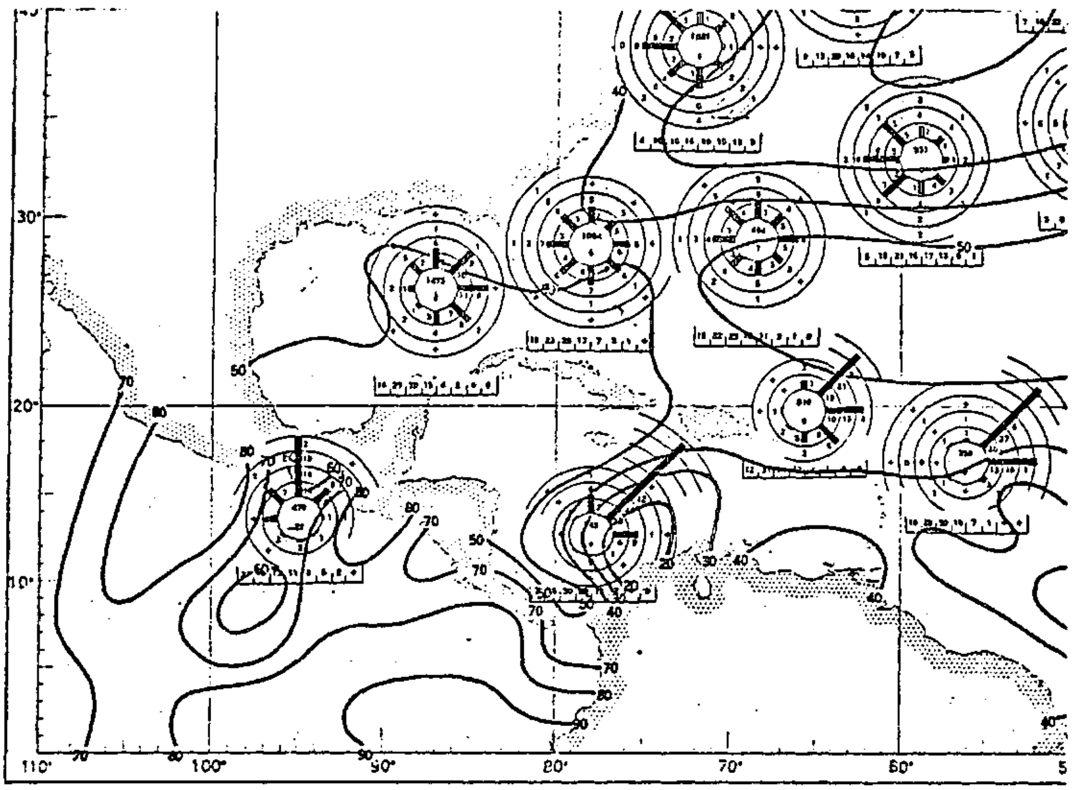


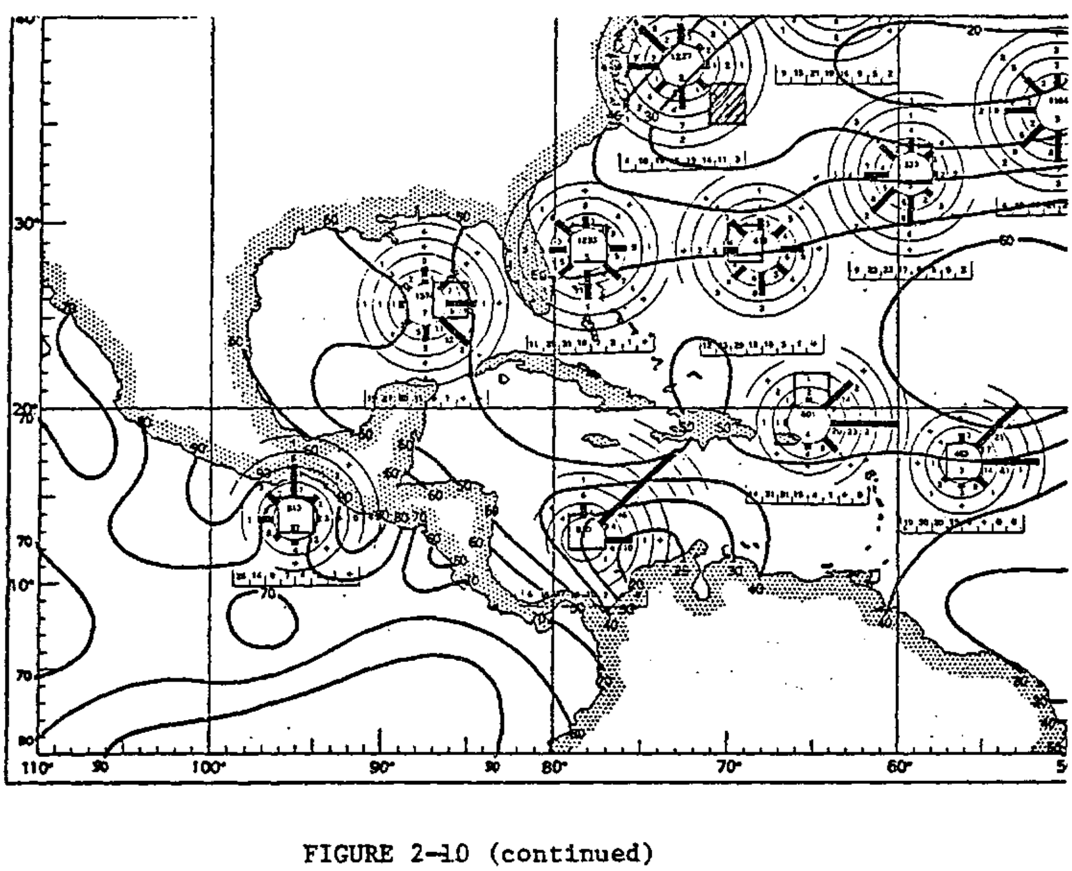
FIGURE 2-10 : Surface Wind Roses for Wider Caribbean Area

Source: Marine Climatic Atlas of the World

SURFACE WINDS



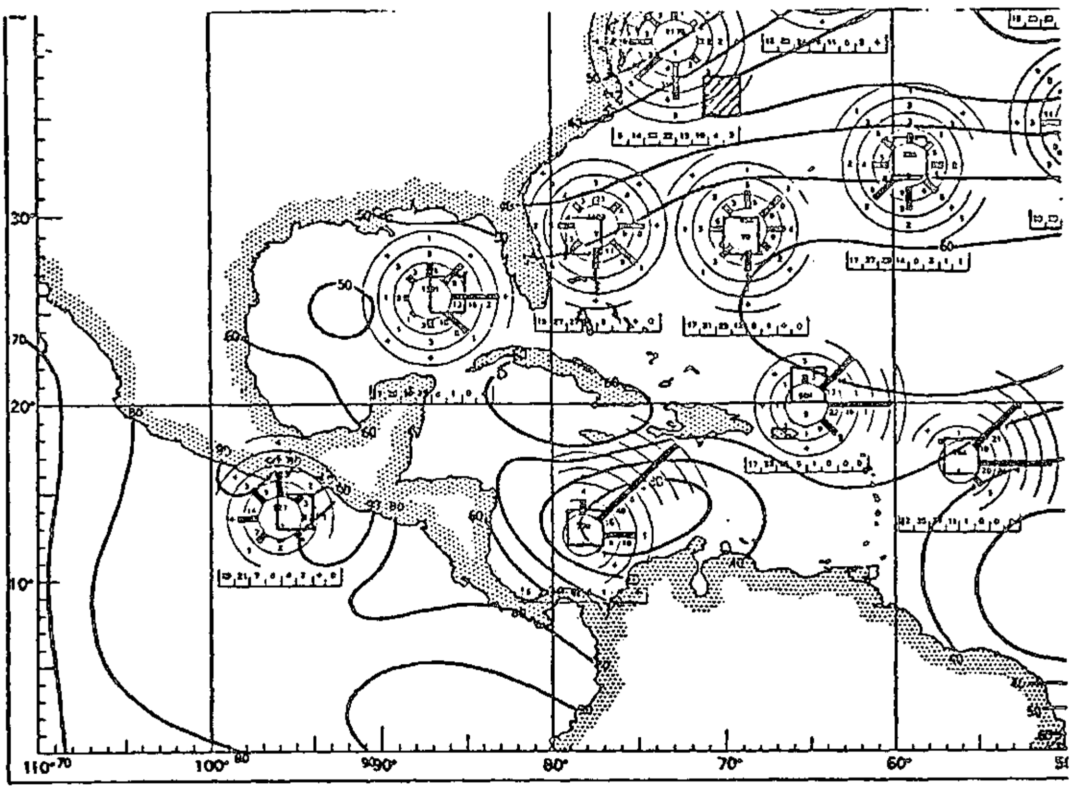
#16
Feb



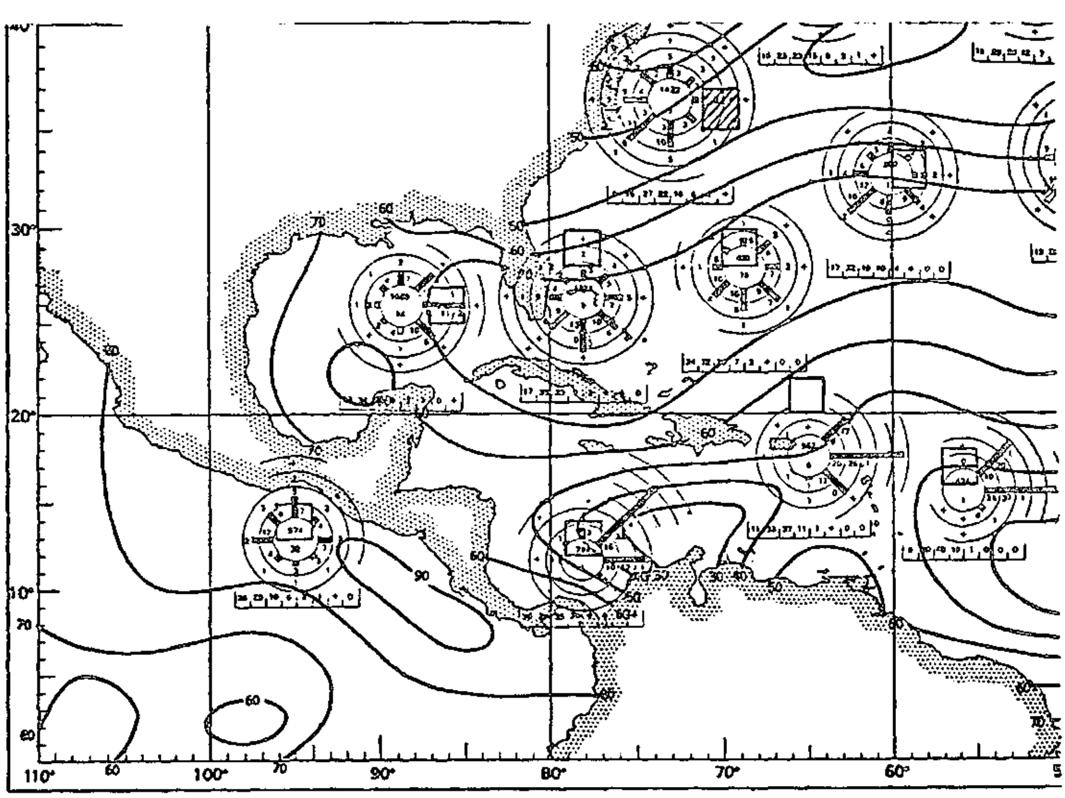
#28
Mar

FIGURE 2-10 (continued)

SURFACE WINDS



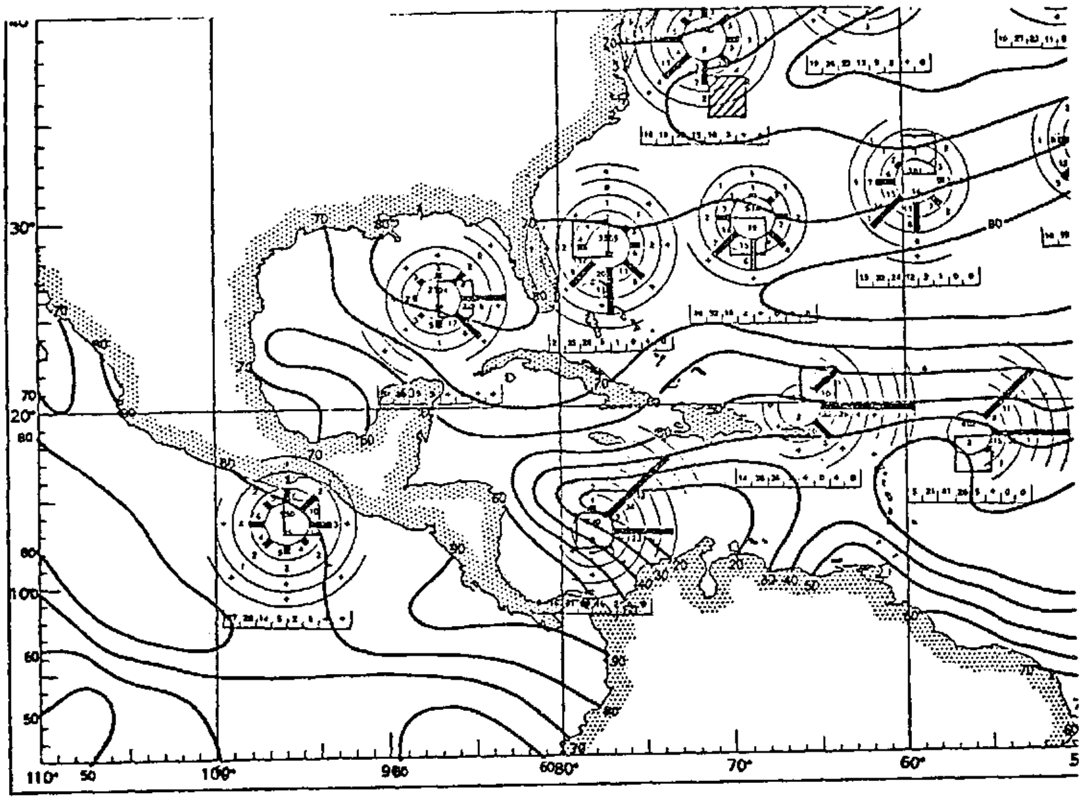
#40
Apr



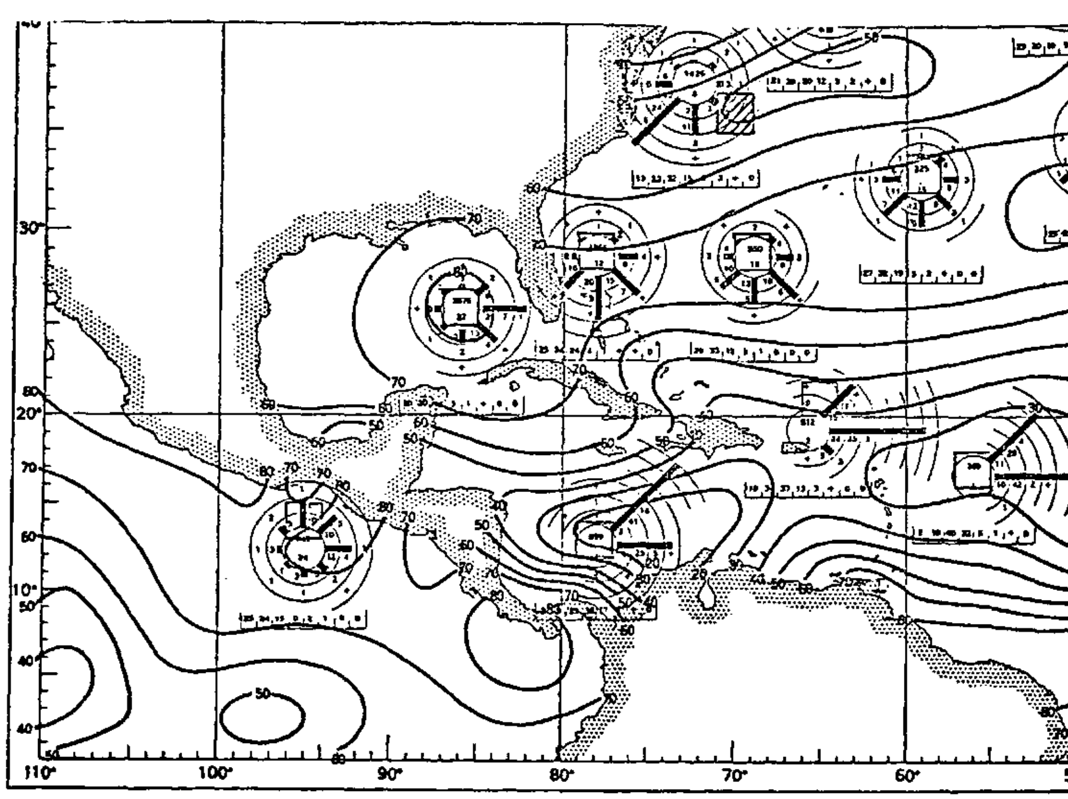
#54
May

FIGURE 2-10 (continued)

SURFACE WINDS



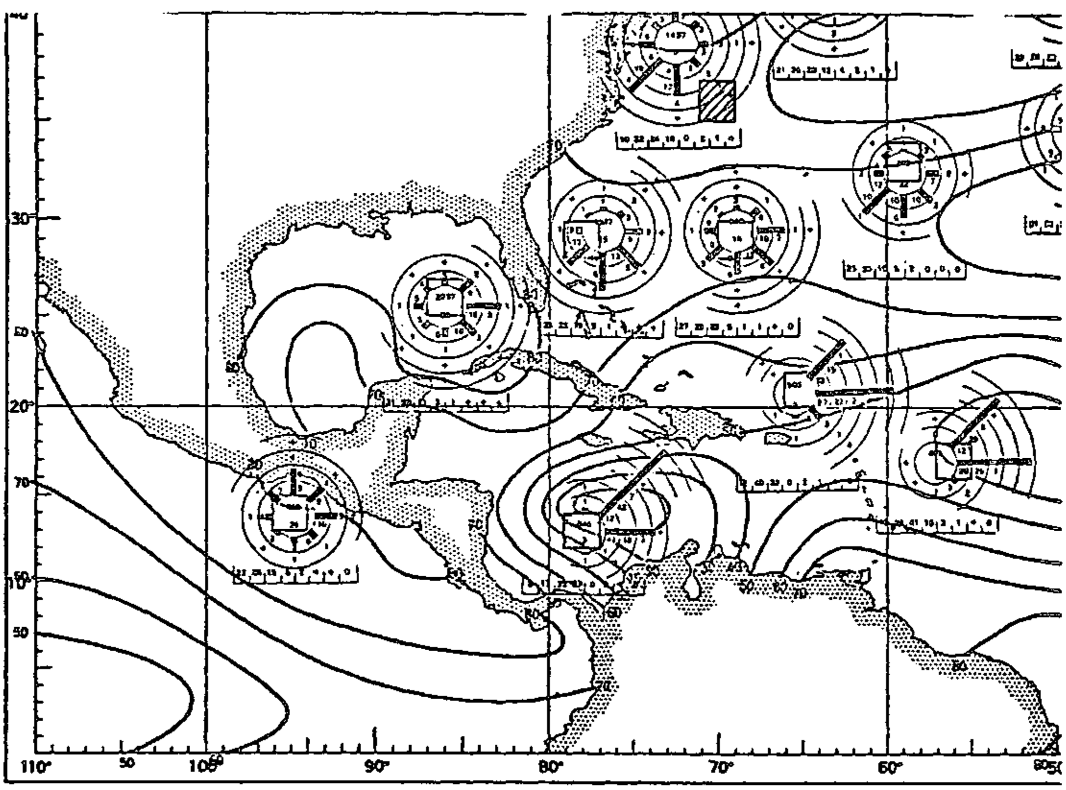
#66
Jun



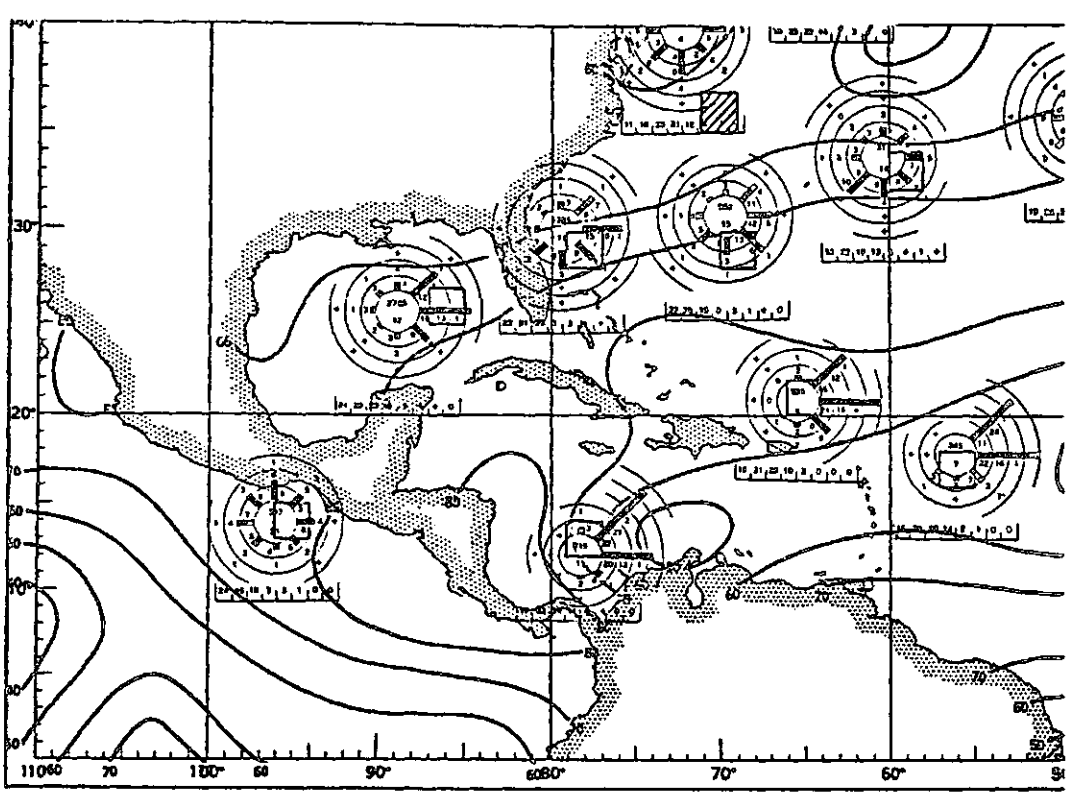
#78
Jul

FIGURE 2-10 (continued)

SURFACE WINDS



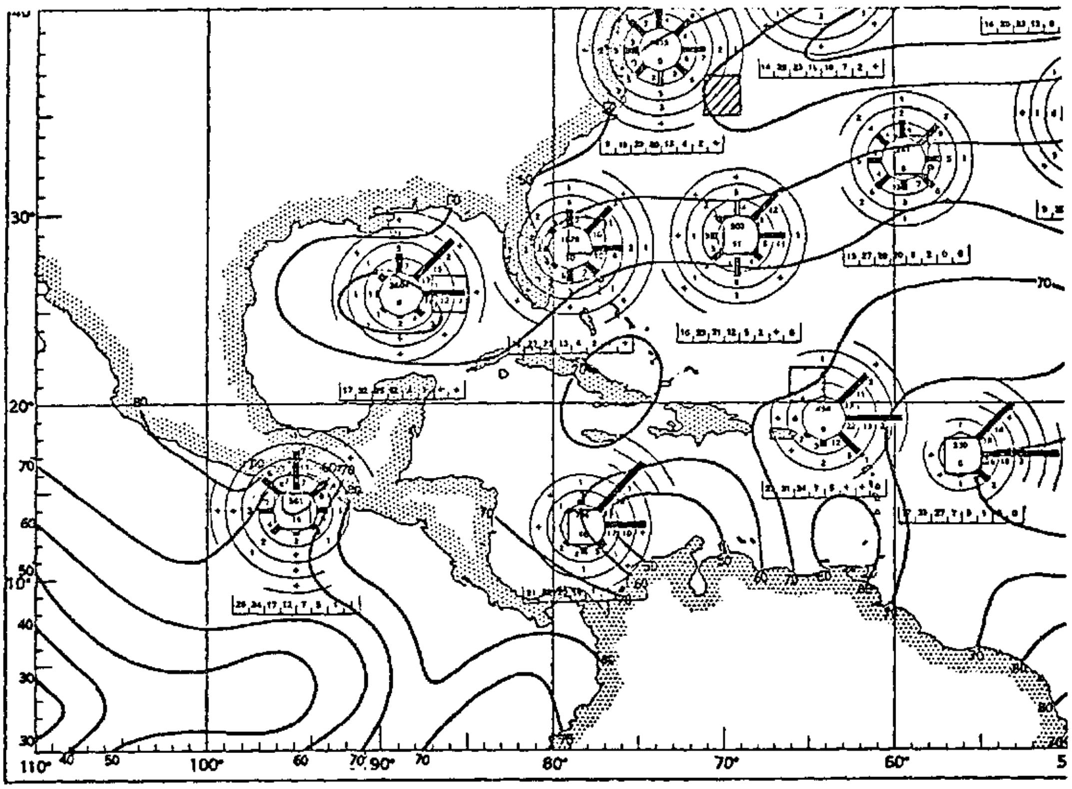
#92
Aug



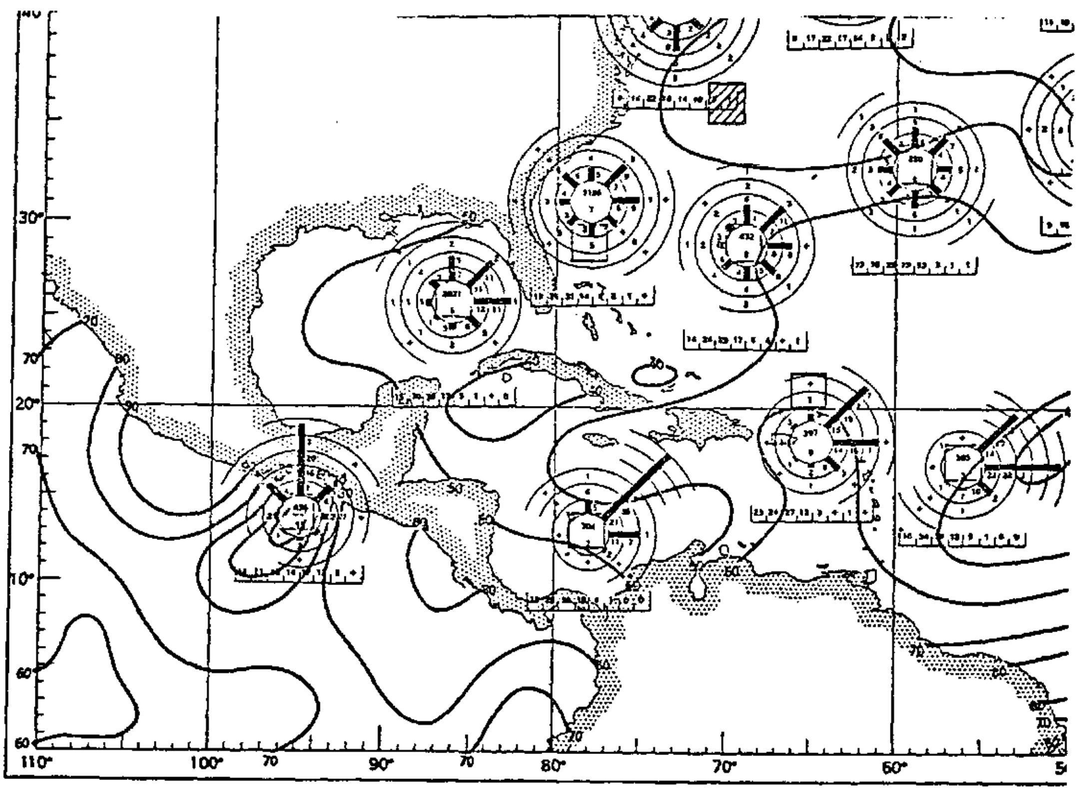
#104
Sept

FIGURE 2-10 (continued)

SURFACE WINDS



#116
Oct



#130
Nov

FIGURE 2-10 (continued)

SURFACE WINDS

#142
Dec

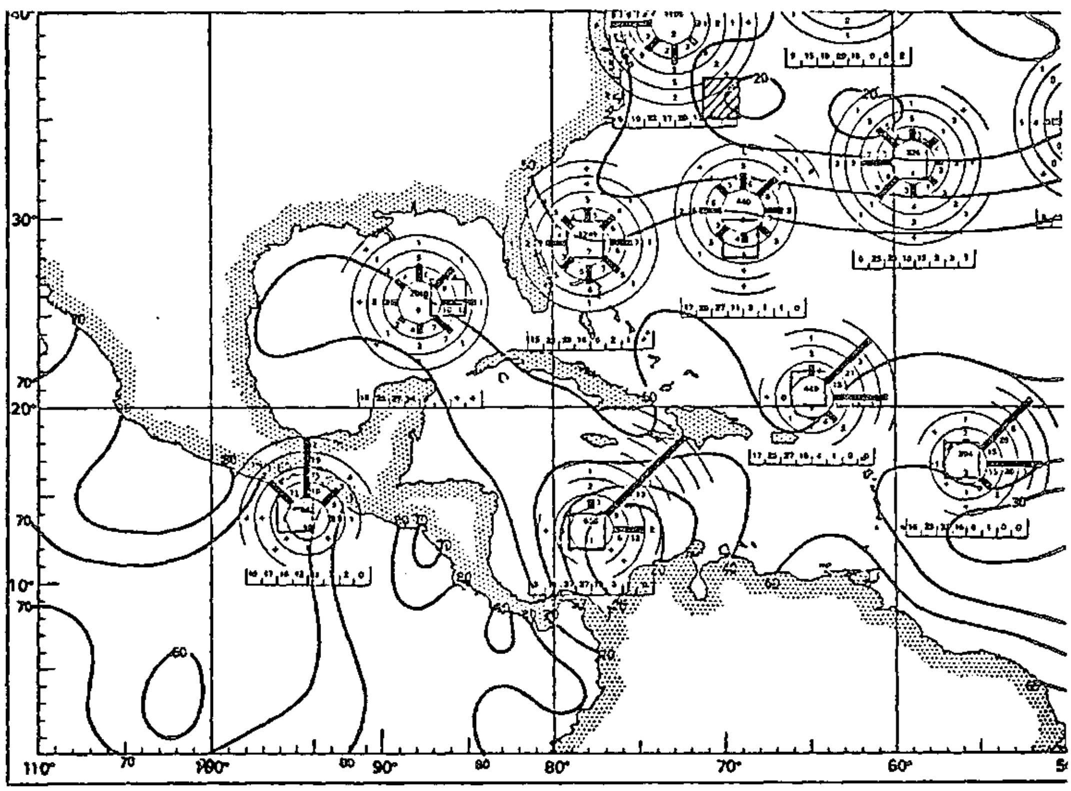


FIGURE 2-10 (continued)

wind is blowing at about 3.5% of the wind speed.

Surface Temperatures of Sea and Air

The surface water temperature in the wider Caribbean region averages about 27°C annually. The fluctuations of temperature in the southern part of the Gulf of Mexico is generally less than ±3°C. The northern part of the Gulf of Mexico experiences seasonal temperature changes from about 16°C to 28°C in the winter or summer. This results in a strong surface gradient in latitudinal temperature during the winter. Figure 2-11 shows the water surface and air temperature variation for four selected months including January, March, July and September. Figure 2-11A is the legend that is to be used with Figure 2-11.

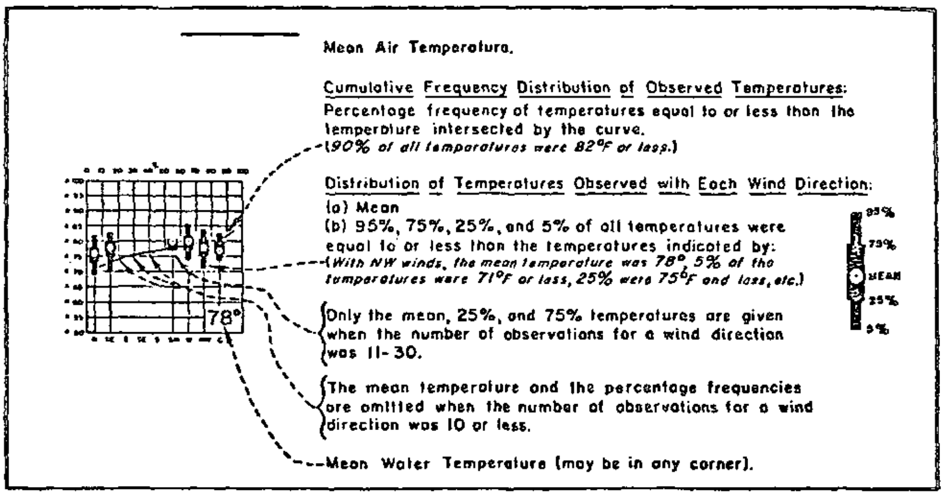
The winter cooling of the surface waters may affect the vertical velocity distribution in the northern and central part of the wider Caribbean region. Thermoclines are sometimes formed during the winter as far below the surface as 100 meters. These waters are typically 10 to 15°C cooler than at the surface.

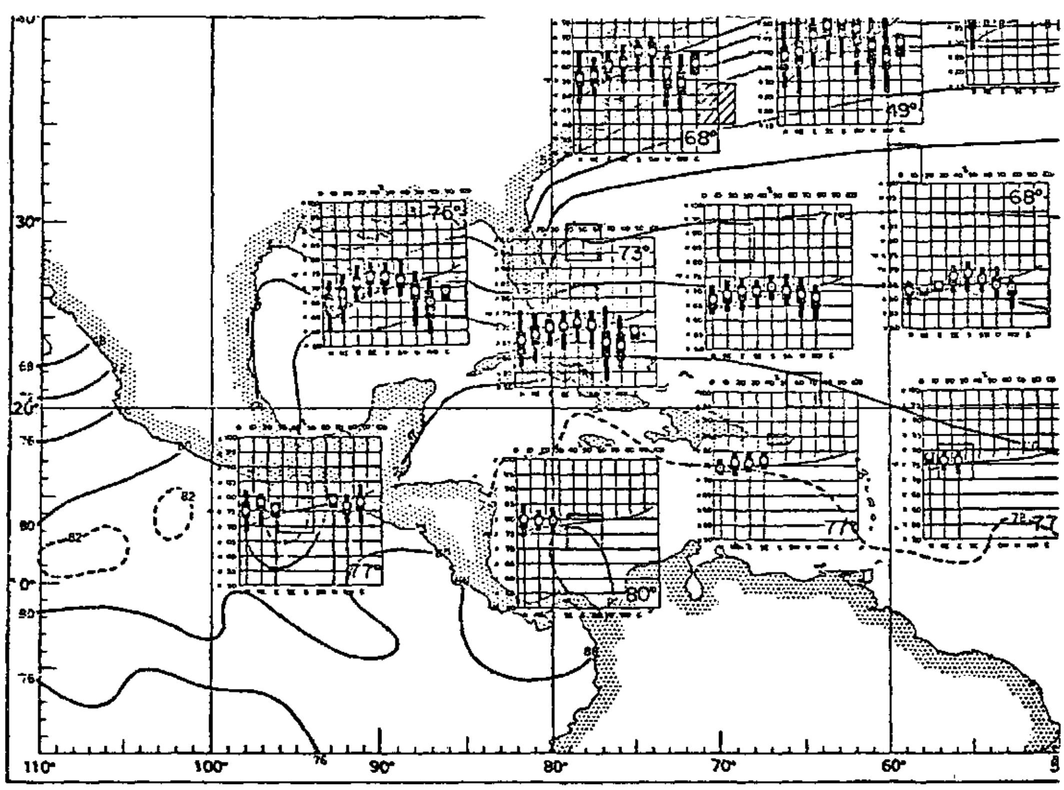
Although temperature gradients do not play the most important role in determining the movement of oil, they do account for the peak upwelling near June along Yucatan's northern coast. Upwelling peaks along the Venezuelan coast between December and April.

In terms of evaporation, spreading and solubility, the difference in surface water and surface air temperature becomes important. Each phenomena will increase with an increase in temperature. In the wider Caribbean, the gradient temperature of air/water at the waters surface varies seasonally averaging about 3°C. The southern part of the region has a net difference of about 1°C, increasing to 5°C, as one travels northward toward the Gulf Coast.

TEMPERATURE

Figure 2-11A





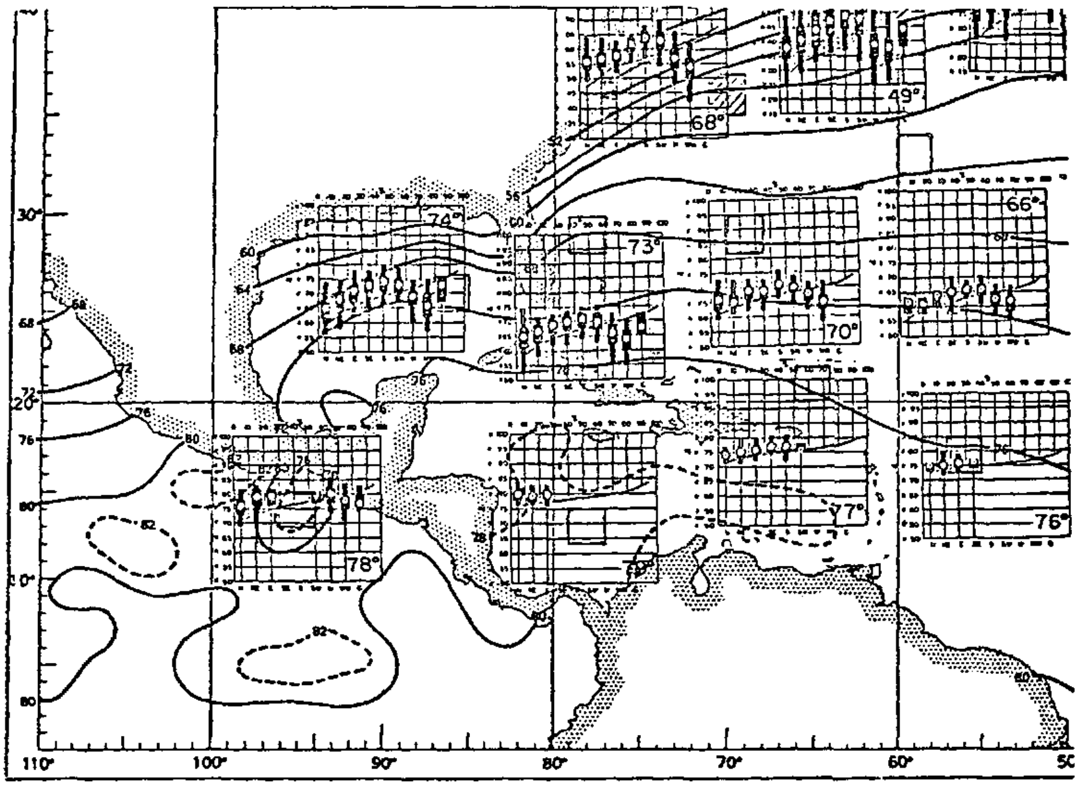
#10
Jan

FIGURE 2-11: Typical Sea-Surface and Air Temperature frequency for Wider Caribbean Area

Source: Navy Marine Climatic Atlas of the World, Vol. I, North Atlantic Ocean.

TEMPERATURE

#24
Feb



#36
Mar

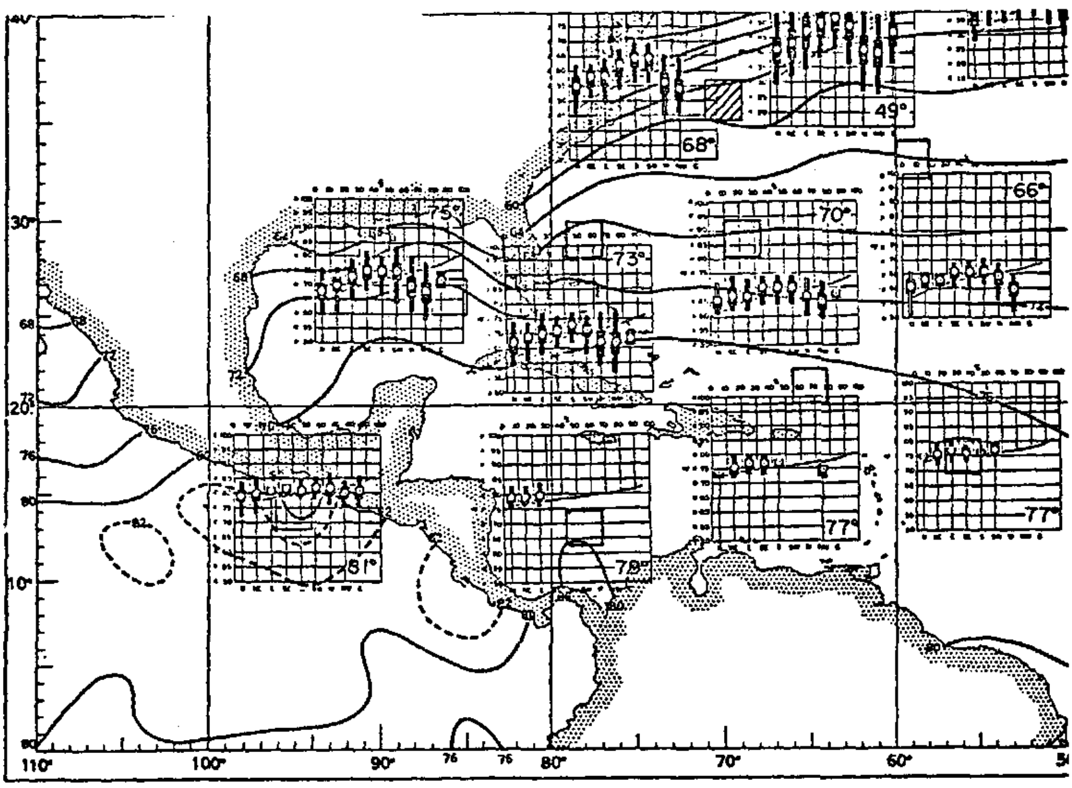
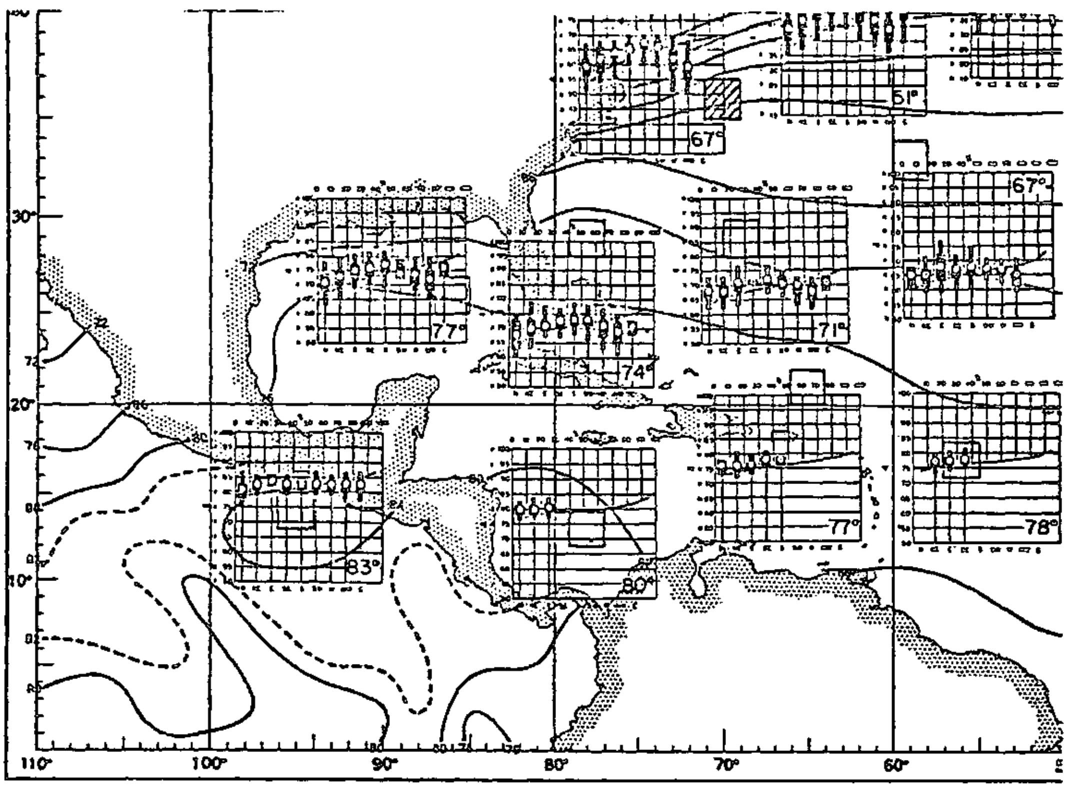


FIGURE 2-11 (continued)

TEMPERATURE

#48
Apr



#62
May

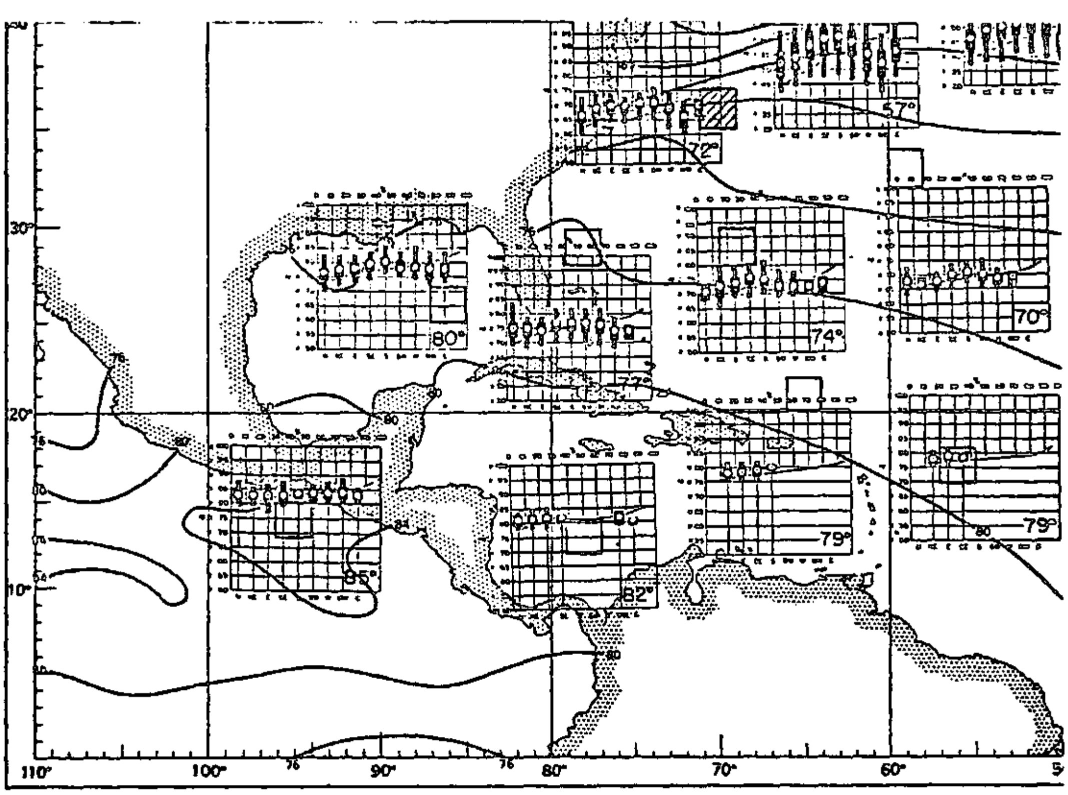
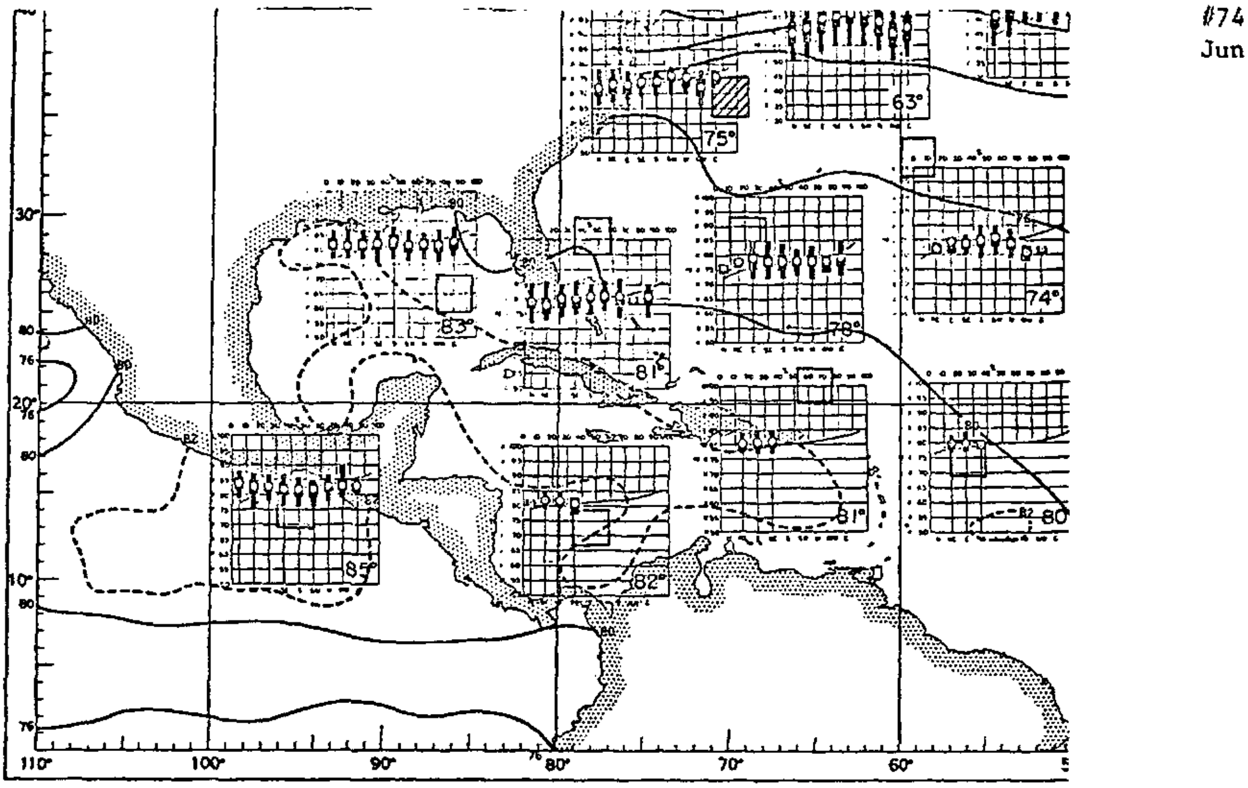


FIGURE 2-11 (continued)

TEMPERATURE



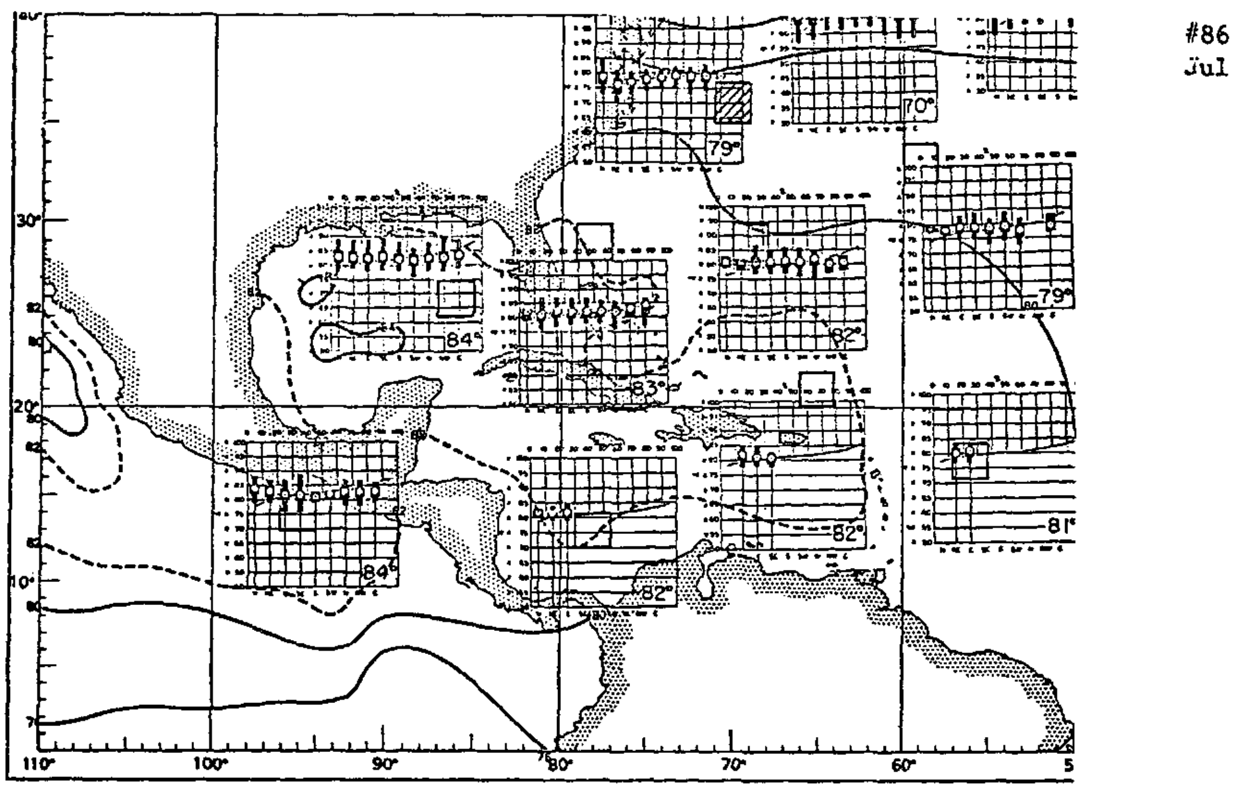
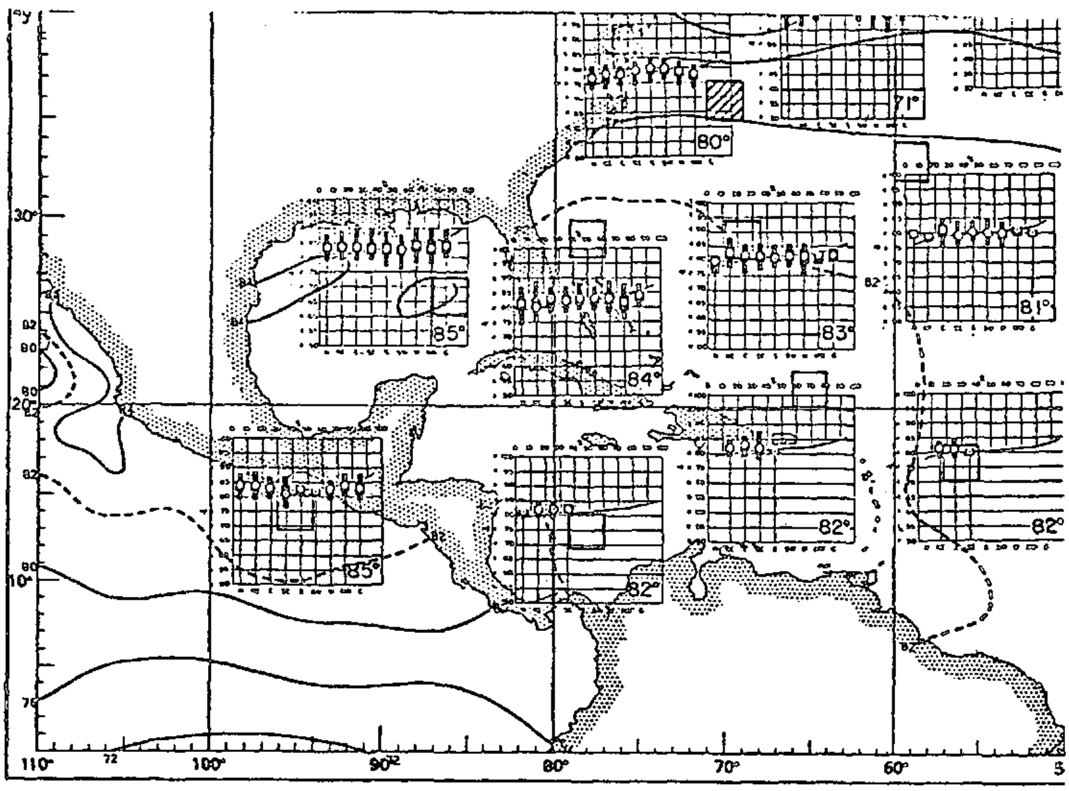
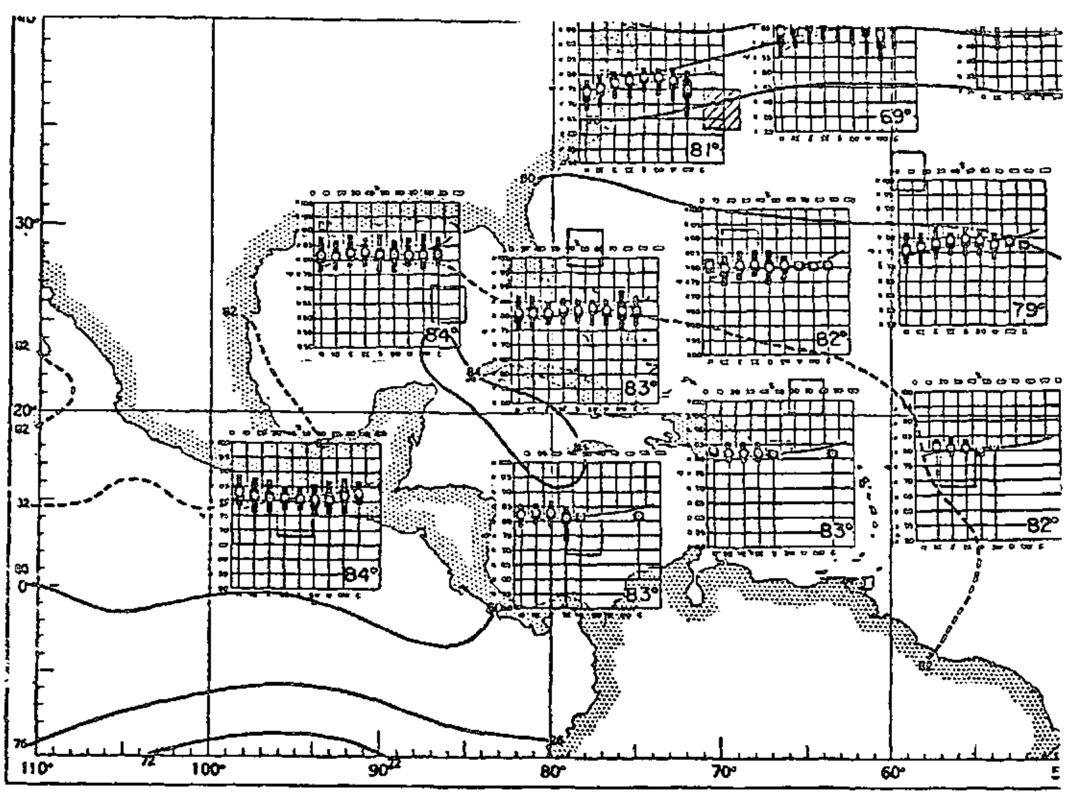


Figure 2-11 (continued)

TEMPERATURE



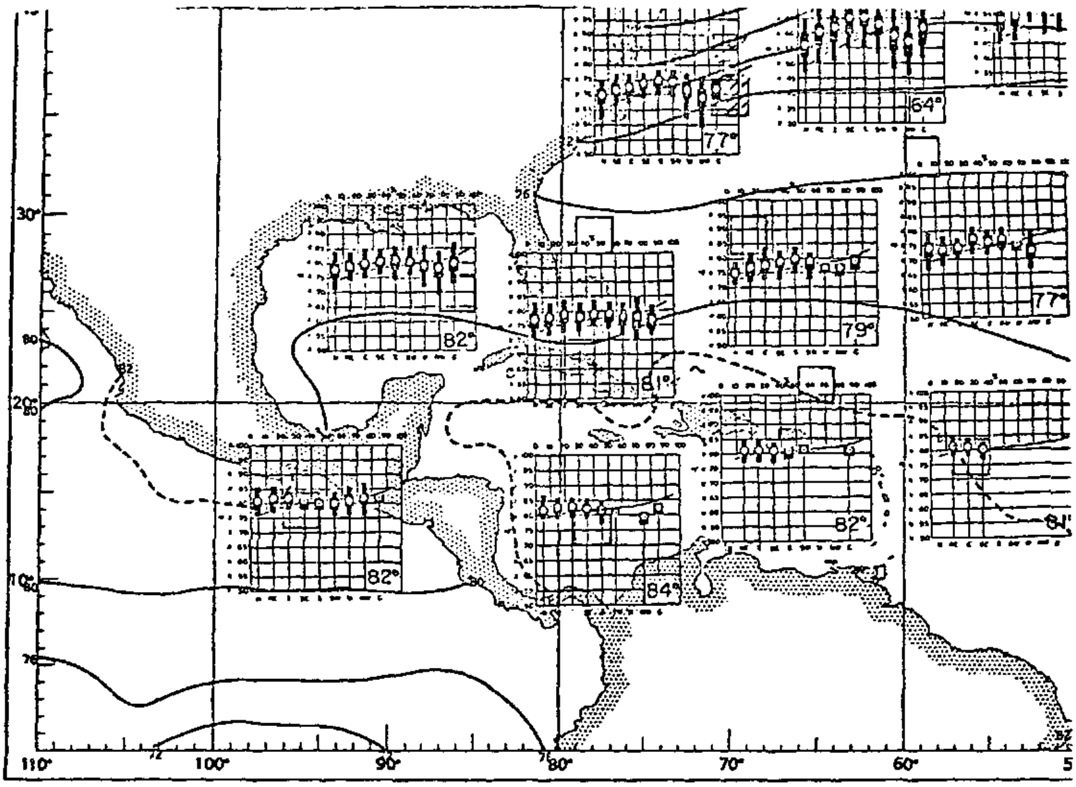
#100
Aug



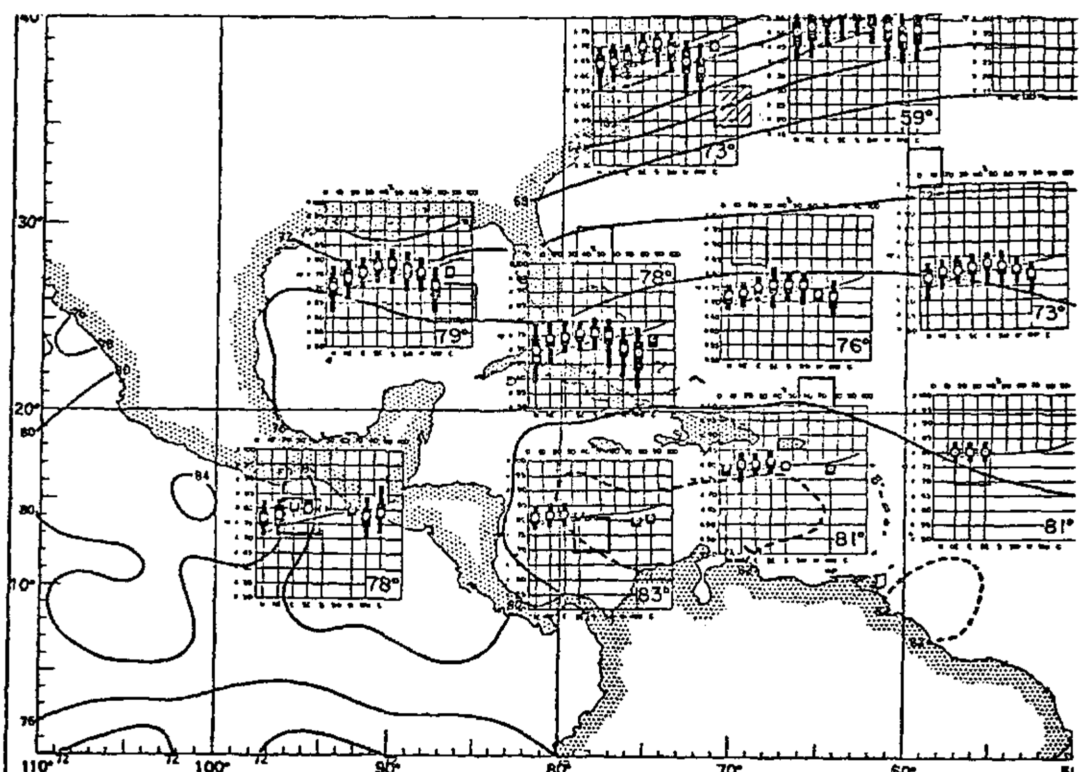
#112
Sept

FIGURE 2-11 (continued)

TEMPERATURE



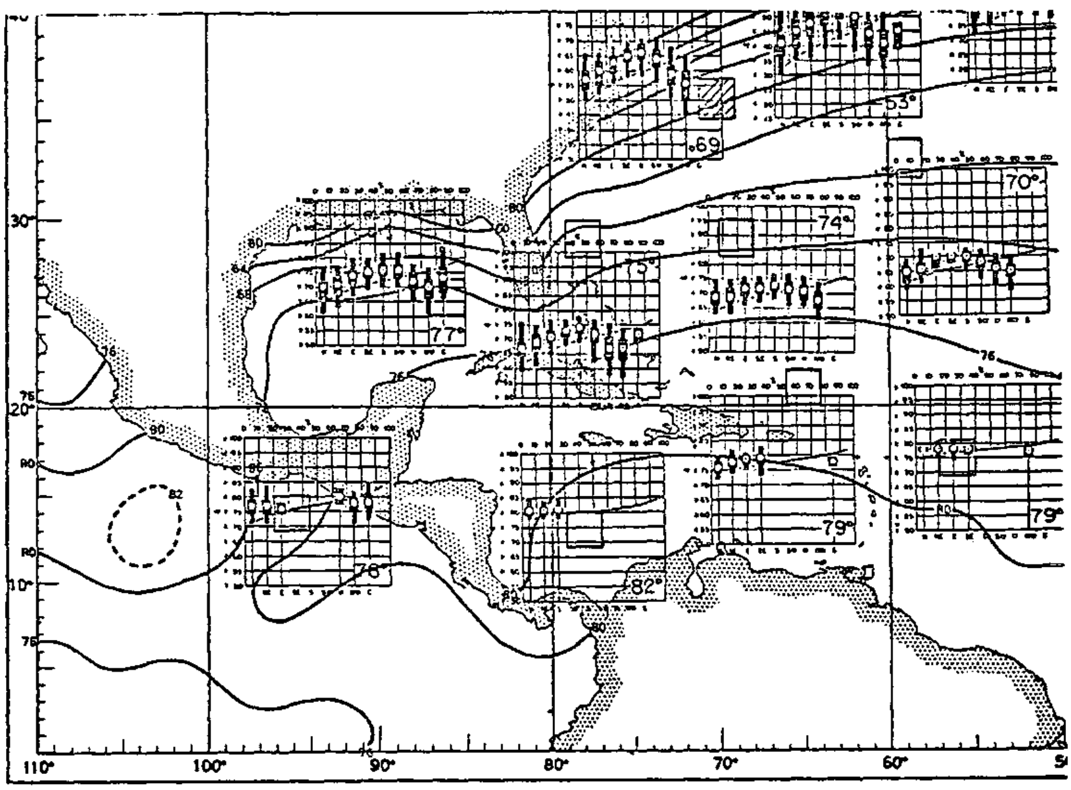
#124
Oct



#138
Nov

FIGURE 2-11 (continued)

TEMPERATURE



#150
Dec

FIGURE 2-11 (continued)

Geology in the Wider Caribbean Region

The type of geology discussed in this part of the report includes coastal geology with emphasis on coastal morphology. The morphology of coastlines is important in providing a basis on which other relevant facotrs such as biological habitats and physical processes are tied. A coastline of a young mountain range coast backed by cliffs in bedrock with beaches of coarse gravel presents a different set of environmental conditions than does a low lying coastal plain shoreline with mud flats and marsh areas (Hayes, 28).

The coastlines found in the wider Caribbean region are classified as collision coasts and Amero-trailing edge coasts in terms of plate tectonics. As a general rule, collision coasts are characterized by steep, rocky shores and coarse grained sediments experiencing high wave energy. Amero-trailing edge coasts are usually dominated by coastal plain shorelines composed of river deltas and barrier islands.

In terms of hydrographic regime there exists two types of coasts in the wider Caribbean area. Wave dominated coasts are seen along the Gulf coast of the United States. They are common where the tidal range is less than 2 meters. Normally, grain size ranges from coarse to fine away from shore. Mixed energy coasts occur where tide ranges are less than four meters, but greater than two meters. This type of coast is common to the wider Caribbean area. Open mouth estuaries and large tidal deltas and marshes are typical of the mixed energy type of coast.

The soils of the wider Caribbean region are diverse. The predominant soil types found in the region are presented in Table 2-4. Each area dis-

TABLE 2-4

DOMINANT SOIL ORDERS AND SUBORDERS FOR THE

WIDER CARIBBEAN REGION*+

ORDER	SUBORDER	SYMBOL	DESCRIPTION
Alfisols			Podzolic soils of middle latitudes; soils with gray to brown surface horizons; subsurface horizons of clay accumulation; medium to high base supply.
	Udalfs	A2	Temperature to hot; usually moist (Gray-brown Podzolic*)
	Ustalfs	A3	Warm subhumid to semi-arid; dry >90 days(some Reddish Chestnut and Red and Yellow Podzolic soils*)
Aridisols	Aridisols	D1	Pedogenic horizons lower in organic matter and dry for >6 mo. of the year. (Desert and Reddish Desert*) Salts may accumulate on or near surface. (not differentiated)
Entisols			Soils without pedogenic horizons on recent alluvium, dune sands, etc.; varied in appearance.
	Aquents	E1	Seasonally or perennially wet; bluish or gray and mottled.
Inceptisols			Immature, weakly developed soils; pedogenic horizons show alteration but little illuviation; usually moist.
	Aquepts	I2	Seasonally saturated with water (includes some Humic Gley, alluvial tundra soils*).
Mollisols			Soils of the steppe (incl. Chernozem and Chestnut soils*). Thick, black organic rich surface horizons and high base supply.
	Rendolls	M3	Formed on highly calcareous parent materials (Rendzina*).
	Ustolls	M5	Temperature to hot; dry for >90 days (incl. some Chestnut and Brown soils*).
Spodosols			Soils with a subsurface accumulation of amorphous materials overlaid by a light colored, leached sandy horizon.

TABLE 2- 4

(Continued)

ORDER	SUBORDER	SYMBOL	DESCRIPTION
	Aquads	S2	Seasonally saturated with water; sandy parent materials.
Ultisols			Soils with some subsurface clay accumulation; low base supply; usually moist and low inorganic matter; usually moist and low in organic matter; can be productive with fertilization.
	Udults	U3	Low in organic matter; moist; temperature to hot (Red-Yellow Podzolic; some Reddish-Brown Lateritic soils*).
Vertisols			Soils with high content of swelling clays; deep wide cracks in dry periods dark colored.
	Uderts	V1	Usually moist; cracks open >90 days.
Mountain Soils			Soils with various moisture and temperature regimes; steep slopes and variable relief and elevation; soils vary greatly within short distance.
		X3	Udic great groups of Alfisols, Entisols and Ultisols; Inceptisols.
		X4	Ustic great groups of Alfisols, Entisols, Inceptisols, Mollisols and Ultisols.

+Source: Goodes World Atlas, Rand McNally.

Legend: Arid (id) L. aridus, dry
Spod (od) Gr. spodus, wood ash
Ult (ult) L. ultimus, last
Vert (ert) L. verto, turn

Names of suborders have two parts. The first suggest diagnostic properties of the soil (see below), and second is the formative element from the order name, eg. id (Arid).

Aqu L. aqua, water soils which are wet for long periods
Arg L. argilla, clay soils with a horizon of clay accumulation
Rend from Rendzina high carbonate content
Ud L. udus, humid soils of humid climate
Ust L. ustus, burnt soils of dry climates with summer rains

cussed is shown on a map of the wider Caribbean region in Figure 2-12. No attempt has been made to estimate on a small scale the type and location of soil types in the region. However, a qualitative summary of soil features typical of the region is provided by Table 2-4 and Figure 2-13.

Coastal physical features are discussed to a greater extent in Section 5 of this report. Features are discussed as related to shoreline type.

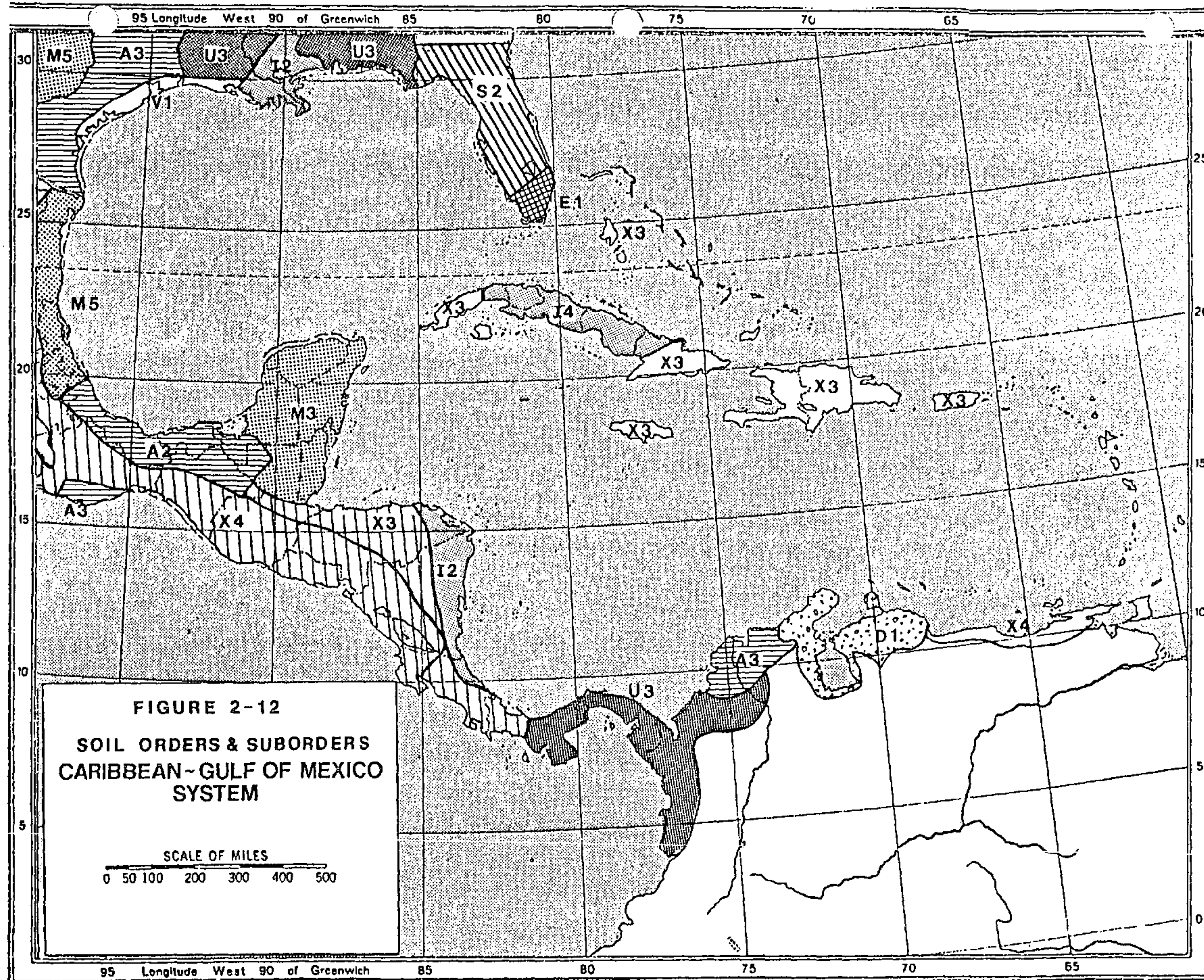


FIGURE 2-12

SOIL ORDERS & SUBORDERS
CARIBBEAN~GULF OF MEXICO SYSTEM

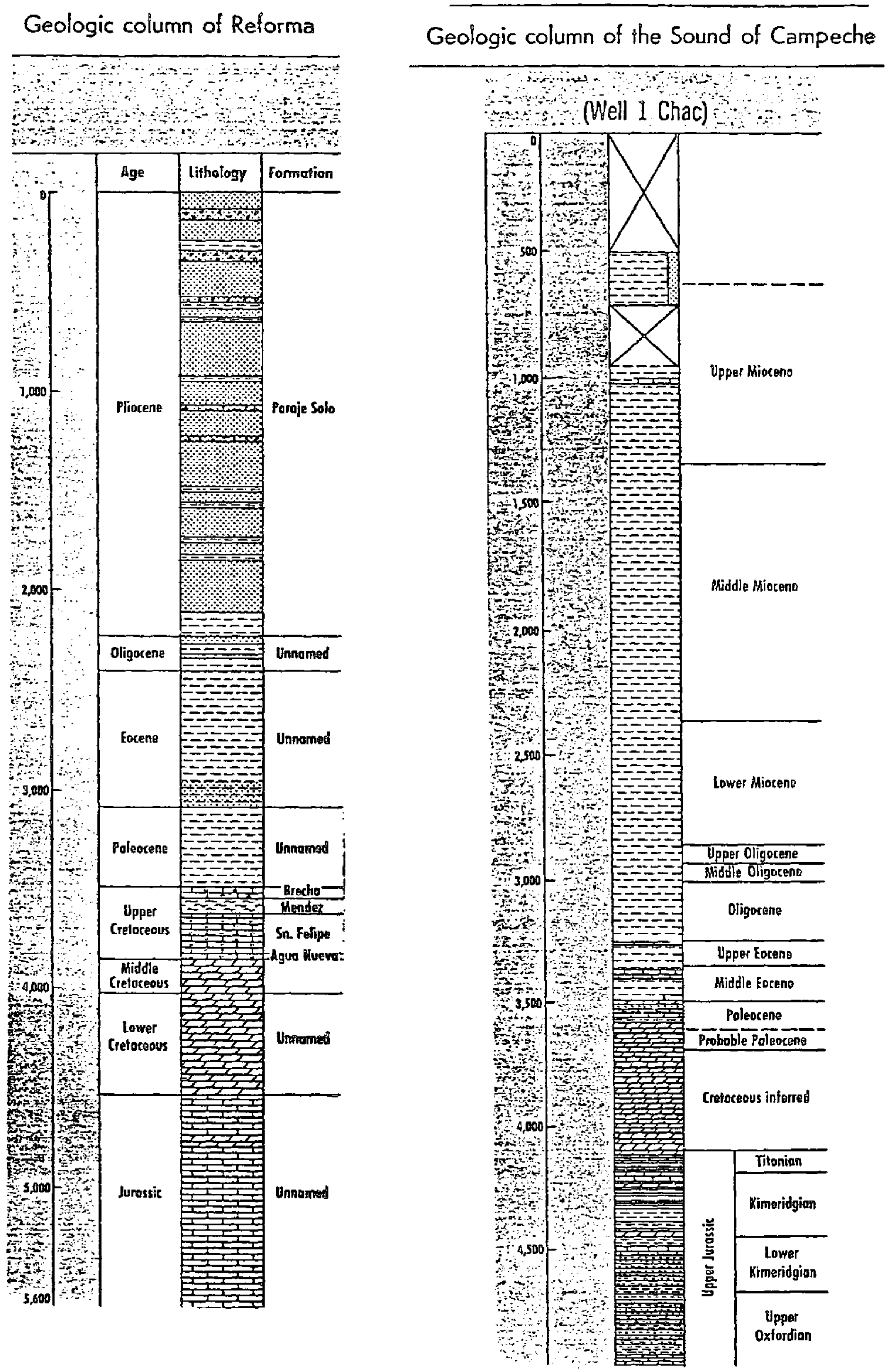


FIGURE 2-13: Typical Geological Formation Cross-Section Depth Profile.
* Source: 1978 IPE

Biology of the Wider Caribbean Region

The biology of this region includes a large number of species of the many biological communities known to exist, therefore no attempt has been made in this report to present in depth or complete knowledge of biology in the region. Several biological habitats and the communities found in and around them will be discussed.

Biological habitats common to the wider Caribbean region are beaches, rocky shores, salt grass, marshes, mangrove marshes, and the ocean water. Each of these habitats is populated by many different kinds of organisms common to only a particular habitat. Biological communities including birds, mammals, vegetation and reptiles are common to beach and marsh habitats and also to the rocky shore habitat. Higher marine organisms such as shrimp, crab, fish and clams are usually found in the ocean water habitat. Table 2-5 lists biological communities for the Gulf of Mexico habitat type.

Habitats and biological communities are discussed in greater detail in Section 5. Their vulnerability to oil damage will also be presented in Section 5.

Table 2-5

BIOLOGICAL COMMUNITIES FOR THE GULF OF MEXICO
BY HABITAT TYPE

Biological Community	Gulf of Mexico	Beach and Dunes	Marsh and Spoil Bank	Marsh
BIRDS		Wilson's Plover	Yellow-Crowned Night Heron	White Pelican
		Baird's Sandpiper	Wilson's Plover	Double-Crested Cormora
		Black-Bellied Plover	Ruddy Turnstone	Great Blue Heron
		Laughing Gull	Black-Bellied Plover	Green Heron
		Common Tern	Willet	Reddish Egret
		Least Tern	Least Sandpiper	Common Egret
		Caspian Tern	American Avocet	Louisiana Heron
		Royal Tern	Black-Necked Still	Yellow-Crowned Night Heron
		Common Nighthawk	Great Blue Heron	Wood Ibis
		Horned Lark	Snowy Egret	White-Faced Ibis
			Black Duck	Snow Goose
			Mottled Duck	Mottled Duck
			Peregrine Falcon	Blue-Winged Teal
			Laughing Gull	Shoveler
			Common Tern	Clapper Rail
			Least Tern	Long-Billed Curlew
			Black Tern	Willet
				Greater Yellowlegs
				Lesser Yellowlegs
				Short-Eared Owl
MAMMALS		California Black-Tailed Jackrabbit	Hispid Cotton Rat	
			Eastern Cottontail Rabbit	
			Armadillo	
			Canid Species	
VEGETATION		Sea Purslane	Saltmeadow Cordgrass	
		Fimbry	Lazy Daisy	
		Largeleaf Pennywort	Saltwort	
		Sand Rosegentian	Glasswort	
		Beach Evening Primrose	Sea Ox-eye Daisy	
			Camphor Daisy	
			Saltgrass	
			Shoregrass	
			Gulf Cordgrass	

Table 2-5 (continued)

BIOLOGICAL COMMUNITIES FOR THE GULF OF MEXICO
BY HABITAT TYPE

Biological Community	Gulf of Mexico	Beach and Dunes	Marsh and Spoil Bank	Marsh
HIGHER MARINE ORGANISMS	Grass Shrimp White Shrimp Brown Shrimp Blue Crab Seabob Squid Sea Pansy Starfish Atlantic Croaker Sand Dollar Spot Bay Anchovy Longspine Porgy Silver Seatrout Shoal Flounder Fringed Flounder Spotted Whiff Gafftopsail Catfish Banded Drum Pinfish			
REPTILES		Western Diamondback Rattlesnake	Western Diamondback Rattlesnake	

SECTION 3

OIL PRODUCTION AND REFINING IN THE WIDER CARIBBEAN REGION

Oil Production in the Gulf of Mexico and the Caribbean

Offshore oil production can be found in Texas, Louisiana, and Mexico for the Gulf of Mexico. Venezuela and Trinidad and Tobago have major offshore production in the Caribbean Sea. Inland production takes place in Barbados, Colombia, Guatemala, Mexico, the states of Texas, Louisiana and Alabama, Venezuela, and Trinidad and Tobago.

The wider Caribbean oil production by country for calendar years 1975 through 1978 is shown in Table 3-1. Detailed information about the individual fields in each country is shown in Table 3-2. Included are data such as discovery date, number and type of wells, flow rate and cumulative flow and type of oil.

Major oil production countries in the region produce about 8 billion barrels of crude oil per day. Figure 3-1 shows the 1978 estimated total oil production for major countries and states bordering the Gulf of Mexico. These numbers include both offshore and inland oil production. Offshore oil production for 1978 is represented in Figure 3-2. Percentages shown indicate the relative amounts of production for locations within the Gulf of Mexico and the Caribbean area. The numbers are the volume of offshore oil produced in 1000 barrels per day.

The estimated offshore production for the entire region is over 3.1 million barrels per day. The Gulf of Mexico offshore areas produced in excess of 2 million barrels per day while the Caribbean offshore production was estimated near 1.1 million barrels per day. Nearly one-third of the total oil production was offshore for the entire region.

Table 3-1
WIDER CARIBBEAN OIL PRODUCTION*
BY CALENDAR YEAR
1975 - 1978

top figure = 1000 BBL/day
bottom figure = Million tons/year

	1975	1976	1977	1978
Barbados	0.3	0.4	0.3	450.0
	0.015	0.02	0.015	22.5
Colombia	160.0	147.0	140.0	130.0
	7.9	7.3	7.0	6.5
Mexico	705.0	831.0	990.0	1,270.0
	34.7	41.4	49.3	63.5
United States				
Alabama	no data	no data	no data	8.7
	no data	no data	no data	0.43
Florida	no data	no data	no data	86.8
	no data	no data	0.5	4.3
Louisiana	no data	no data	203.0	635.0
	no data	no data	10.1	31.8
Mississippi	no data	no data	no data	26.0
	no data	no data	no data	1.3
Texas	no data	no data	1,682.0	1,930.0
	no data	no data	84.0	96.5
Trinidad & Tobago	205.0	224.0	230.0	240.0
	10.1	11.2	11.5	12.0
Venezuela	2,345.0	2,290.0	2,280.0	2,150.0
	115.6	114.0	113.5	107.5
TOTAL	3,415.0	3,492.0	5,536.0	6,930.0
	168.3	173.9	275.9	346.5

* Source: 1978 and 1979 International Petroleum Encyclopedia

Table 3-2

WIDER CARIBBEAN PRODUCTION*

•Offshore (e) Estimated (c) Condensate (NA) Not available

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
BARBADOS									
	Woodbourne,'66	6,000	7	11	...	3	725	600,574	32.0
	Other	.....	...	1	...	1	7	41,188	32.0
	Total		7	12		4	732	641,762	
COLOMBIA									
	Castilla,'76	7,400	...	1	...	...	664	286,994	13.2
	Bonanza, '64	4,000	1	10	3	2	1,338	9,438,733	30.0
	Boquete, '61	8,000	10	...	3	...	1,813	14,051,201	43.0
	Burdine, '74	11,000	1	...	1	...	1,258	1,138,840	26.3
	Casabe, '41	3,880	...	249	...	8	4,085	205,496,114	20.7
	Cantagallo,'41	6,800	...	13	...	...	670	15,658,623	19.7
	Cocorna, '63	2,000	...	13	...	5	614	4,551,428	12.6
	Dina, '62	2,900	3	21	...	7	7,752	14,708,782	22.5
	Galan, '45	3,200	...	55	...	20	1,285	16,556,429	19.0
	Infantas, '18	3,200	1	297	...	16	4,064	214,576,448	25.8
	La Cira, '25	3,250	...	604	...	68	12,179	427,569,100	24.0
	Lisama, '57	9,500	15	22	...	6	4,562	10,407,764	31.0
	Llanito, '60	7,300	...	25	...	6	1,560	11,131,233	21.0
	Loro, '64	9,600	2	1	1	4	867	8,942,269	30.5
	Orito, '63	6,600	2	1	12	5	23,086	141,038,616	39.7
	Ortega, '53	4,300	...	6	...	7	632	10,547,693	27.0
	Palagua, '54	4,500	...	108	...	55	5,041	64,375,171	15.2
	Payoa, '62	8,000	8	4	7	3	4,662	61,281,869	36.7
	Provincia, '62	8,000	8	...	2	7	12,313	117,577,511	33.0
	Pto. Colon,'65	9,600	...	...	3	1	1,212	7,082,614	30.5
	Rio Zulia, '61	6,500	2	13	...	11	7,013	117,992,868	41.4

* Source: 1979 Petroleum Directory of Latin America

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
COLOMBIA (cont.)	Salina, '71	2,500	8	3	...	...	1,379	799,398	24.0
	Tello, '72	4,200	2	6	...	8	5,428	4,631,686	20.2
	Tibu, '40	4,200	12	110	30	35	6,426	208,514,402	37.2
	Velasquez, '45	5,300	...	101	30	65	7,121	146,684,490	22.4
	Yarigui, '54	6,800	...	34	...	...	5,414	82,333,866	19.5
	Other	...	13	93	11	50	4,775	135,514,693	.....
	Total		88	1,790	102	390	127,213	2,052,889,835	
GUATEMALA	Rubelsanto,'74	5,300-7,000	1	...	...	1	700	265,000	26.0-32.0
	Tortugas, '72	2,400	...	...	...	2	...	...	35.0
	W. Chinaja,'77	3,400-4,800	...	...	...	...	...	...	30.0-33.0
	Total		1	...	...	3	700	265,000	
MEXICO Pemex	Monterrey, 50	6,950	...	...	9	...	677	11,119,185	47.0
North zone,NE	Other	...	7	1	9	...	368	11,151,893	
North zone,Ne	Arenque, '70	11,362	23	...	...	...	24,141	44,555,441	26.0
	Barcodon,'59	4,370	6	1	...	...	327	8,907,986	17.0
	Constit., '56	6,300	65	...	41	...	8,332	52,053,883	17.0
	Ebano-Pan.,'01	1,450	68	...	121	...	5,996	929,383,007	12.0
	Tamaulipas,'56	4,200	65	...	41	...	8,042	50,125,186	18.0
	Other		89	...	13	...	307	12,967,426	
North zone,S.	Cabo Nuevo,'67	5,753	1	...	...	...	447	11,050,473	16.0
	•Is. de Lobos'63	6,875	3	...	...	...	938	19,495,949	40.0
	•Marsopa	10,198	6	...	...	...	4,162	7,685,587	36.0

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
MEXICO (cont.)	Naranjos, '09	1,800	201	...	...	...	7,878	1,188,935,058	20.0
	•Tiburon, '65	7,314	5	...	...	...	488	6,101,017	20.0
	Tres Hrm., '59	6,960	33	...	...	...	5,599	95,773,326	21.0
	Other	...	40	1	...	...	2,461	4,335,433	
	•Atún, '66	9,040	7	...	...	...	1,539	30,507,173	37.0
Central zone, P.R.	Bagre, '73	10,919	9	...	...	...	13,230	21,888,697	....
	M.A. Cam. '52	5,340	1	...	9	...	400	3,049,813	35.0
	Cerro Del Carb. 1960	9,396	...	...	19	...	435	3,707,307	....
	Hallazgo,'55	10,170	...	...	66	...	4,241	63,532,661	25.0
	Jiliapa, '58	7,390	...	...	30	...	1,243	25,288,857	34.0
	Miquetla,'59	6,480	18	...	29	...	2,361	19,836,974	35.0
	•Morsa, '71	10,434	1	...	...	...	378	10,145,122	37.0
	Nvo. Prog.'55	7,185	...	...	9	...	299	7,066,111	31.0
	Papantla, '62	9,086	...	...	12	...	287	3,422,578	....
	Poza Rica, '30	7,090	100	63	249	...	49,843	1,139,451,326	35.0
	Remolino,'62	10,745	...	...	48	...	1,368	18,186,095	....
	Riachuelo,'72	10,798	3	...	...	...	277	1,585,596	....
	San Andres,'56	10,410	9	...	144	....	29,257	285,534,122	29.0
	Other	...	69	4	...	...	5,482	39,545,041	....
Central zone, N.F.O.	Acuatempa, '55	4,085	14	...	...	...	1,811	24,680,438	21.0
	Alamo, Jardin, Paso R.,'57	...	21	...	...	...	460	22,586,252	....
	Copal, '57	4,610	7	3	...	...	253	1,802,104	15.0
	El Muro, '66	3,966	4	...	...	...	3,252	15,906,750	17.0
	E. Ordonez,'52	5,220	10	...	...	...	1,376	54,411,242	21.0
	Mesa Cerrada,'56	4,085	6	...	...	...	470	11,021,810	22.0

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
MEXICO (cont.)	Ocotepec, 53	3,737	12	...	...	...	692	18,448,016	20.0
	Sta. Agueda,53	4,789	17	...	...	...	2,941	97.979,078	16.0
	Other	....	92	...	...	...	851	18,232,024	...
Central zone, V.	Angostura,'53	4,405	7	...	...	...	330	22,076,246	15.0
	Matapion.,'74	11,129	19	...	...	...	7,810	3,824,194	37.0
	Other	....	2	...	...	...	261	407,611	...
Southern zone, A.D.	Blasillo,'67	7,216	18	...	21	...	6,071	8,387,916	40.0
	Cinco,Pt,'60	6,862	20	...	88	...	17,556	215,547,142	35.0
	El Burro,'31	2,200	1	3	7	...	1,339	19,163,391	26.0
	La Venta,'54	4,730	7	....	29	...	3,811	53,277,332	41.0
	Ogarrio,'57	5,790	39	...	54	...	13,564	109,717,149	38.0
	Otates,'65	7,469	5	...	7	...	2,322	20,778,342	39.0
	Rodador,'71	11,398	9	...	6	...	2,319	1,966,072	26.0
	Puente, '68	...	...	...	2	...	76	535,845	...
	S. Magal.,'57	4,240	5	...	103	...	7,587	113,196,457	27.0
	Sta. Ana,'59	9,517	1	...	4	...	477	30,200,806	29.0
	San Ramon,'67	9,883	3	...	34	...	8,015	40,795,468	30.0
	Tonala,'28	1,770	2	22	11	...	1,192	74,051,994	28.0
	Other	....	...	...	...	...	...	8,231,264	...
Southern zone, C.	Agave,'77	13,450	4	...	...	...	9,711	2,118,088	41.7
	Artesa,'77	11,800	1	...	...	...	13,296	3,491,667	26.4
	Ayapa, '72	8,200	4	...	...	...	1,476	3,609,064	7.2
	Cach. Lop.,'77	14,750	1	...	...	...	1,086	262,381	39.0
	Cactus, '72	14,100	35	...	...	...	115,700	128,399,814	31.5
	Caracol.,'67	11,480	...	...	4	....	472	3,138,389	....
	Carrizo,'62	3,500	1	...	6	...	1,038	8,521,308	23.3
	Castarri.,'67	10,080	6	...	19	...	3,608	30,801,992	29.3
	Cund.,'74	13,775	21	...	...	...	185,317	130,650,791	28.9
	El Golpe, '63	3,500	16	...	58	...	10,159	60,703,953	25.7
	Iride, '74	13,775	7	...	...	...	27,445	17,939,753	28.6

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
MEXICO									
(cont.)	Mecoacan,'57	2,200	6	...	17	...	3,464	33,619,333	8.6
	Mundo Nvo.,'77	11,800	2	...	...	...	4,226	793,760	46.0
	Nispero,'74	14,100	12	...	...	...	33,197	20,343,426	34.4
	Ojicaque,'77	11,150	3	...	...	...	17,930	3,654,691	29.1
	Paredon,'78	15,690	1	...	...	...	2,391	432,747	39.8
	Platanal,'78	15,900	1	...	...	...	1,985	359,310	30.2
	Rio Nuevo,'75	14,950	2	...	...	...	4,041	3,542,780	34.8
	Samaria, '73	14,209	36	...	...	...	303,338	313,914,099	31.0
	Santuario,'66	9,617	11	...	9	...	7,303	20,726,324	37.0
	Sitio Gr.'72	13,766	17	...	...	...	65,587	108,805,886	35.0
	Sunuapa,'78	....	2	...	...	...	4,491	812,894	....
	Tintal, '68	5,904	5	...	...	...	445	3,002,008	22.0
	Tupilco, '59	9,685	10	...	21	...	5,850	37,175,623	27.0
	Other	....	2	...	...	...	283	5,425,345	....
Southern zone, E.L.	Agata, '56	3,830	4	...	13	...	655	10,431,456	34.0
	Bacal, '76	3,500	8	...	...	...	16,018	4,030,053	35.0
	Concep.,'74	1,600	12	...	...	...	1,600	1,259,679	31.0
	Cuichapa, '35	2,200	15	3	85	...	11,670	98,367,517	30.0
	El Plan, '31	1,700	1	22	47	...	2,774	145,318,210	30.0
	Lacamango,'73	1,700	24	...	...	...	4,388	3,478,968	26.8
	Los Sold. '53	4,492	6	11	...	...	1,180	20,804,779	32.0
	Other	....	1	6	...	...	173	33,973,447	...
Southern zone, NAN.	Sta. Rosa, '26	400	...	10	...	...	137	4,898,558	23.1
	Moloacan,'62	500	3	143	63	...	4,613	12,584,931	22.3
	Ixhuatlan, '65	1,960	9	4	8	...	1,369	6,190,215	22.6
	Other	....	...	...	...	...	...	12,433,657	....
	Total	....	1,438	298	1,771	...	1,134,092	6,429,747,352	....
	Offshore Total						31,646		

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
TRINIDAD-TOBAGO	•Soldado, '55	2,150-11,000	111	40	98	137	43,777	331,470,000	24.8
	Area IV & Guape, '13-'22	1,000-10,626	19	44	...	112	1,713	33,948,000	16.9-25.5
	Parrylands '13-'18	1,000-10,626	15	45	...	208	995	35,105,000	10.7-30.2
	P. Fortin, C&W, '07-'16	1,000 10,626	23	83	...	136	2,621	32,366,000	20.4-45.1
	•Brighton,'08	700-7,500	41	30	68	292	1,730	69,117,000	32.8
	Palo Seco & Erin,'26-'29	240-12,718	36	313	102	447	6,439	86,779,000	21.2
	Forest Res. '13	500-11,000	96	316	248	994	9,641	331,040,000	23.0
	Fyzabad, '18-'20	500-11,000	7	301	7	287	4,243	156,886,000	20.8-32.7
	P. Fortin E., 1929	500-11,000	3	41	6	62	1,108	23,277,000	34.1
	Coora/Quarry 1936	288-14,000	4	139	34	350	3,192	83,161,000	20.4-24.1
	Oropouche,'44	2,707-9,077	3	27	13	47	739	5,398,000	10.8-38.6
	Barrackpore 1911	1,300-11,067	12	26	19	145	1,552	25,568,000	29.9-41.2
	Penal, '36	1,300-11,067	23	58	12	116	1,519	57,954,000	37.5-55.7
	Catshill, '50	1,400-9,693	1	52	...	35	731	21,448,000	38.3-46.3
	Trinity, '56	1,400-9,693	1	27	...	42	564	13,909,000	32.2
	Guayaguayare, 1903	500-10,750	3	135	11	397	3,406	79,108,000	33.7

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
TRINIDAD-TOBAGO (cont.)	•Galeota, '72	1,100-6,304	...	13	...	6	1,364	3,027,000	31.6
	•Teak, '72	6,960-15,991	19	...	18	16	44,536	93,897,000	29.3
	•Samaan, '73	8,719-11,780	29	...	8	3	52,194	85,565,000	36.8
	•Poui, '74	5,921-11,650	20	...	1	1	46,624	43,817,000	34.0
	Other	....	30	441	12	1,184	6,612	144,224,000	....
	Total	....	496	2,131	657	5,017	235,300	1,757,064,000	....
	Offshore Total						190,229		
VENEZUELA									
	Boca, '51	9,500	14	1	6	55	2,346	71,711,205	31.9
Anzoategui	Caico Seco, 1946	6,500-7,300	21	...	6	72	4,610	53,681,267	35.4
	Chimire '48-'52	7,000-7,200	23	...	29	151	6,573	351,580,824	35.9
	Dacion, '57	6,700	8	6	72	51	11,177	188,871,938	21.4
	Elias, '54	5000-6,470	30	4	28	88	11,416	91,721,562	38.3
	El Roble, '39	3,500-11,500	7	...	1	40	956	37,998,179	52.1
	Guico, '44	4,500-7,000	1	3	19	46	1,145	85,020,830	24.3
	Guara, '46	5,000-10,000	13	92	44	225	14,882	519,654,231	24,8
	Guario, '40	5,000-10,000	5	...	...	51	1,384	22,867,650	50.8

Table 3-2
(cont.)

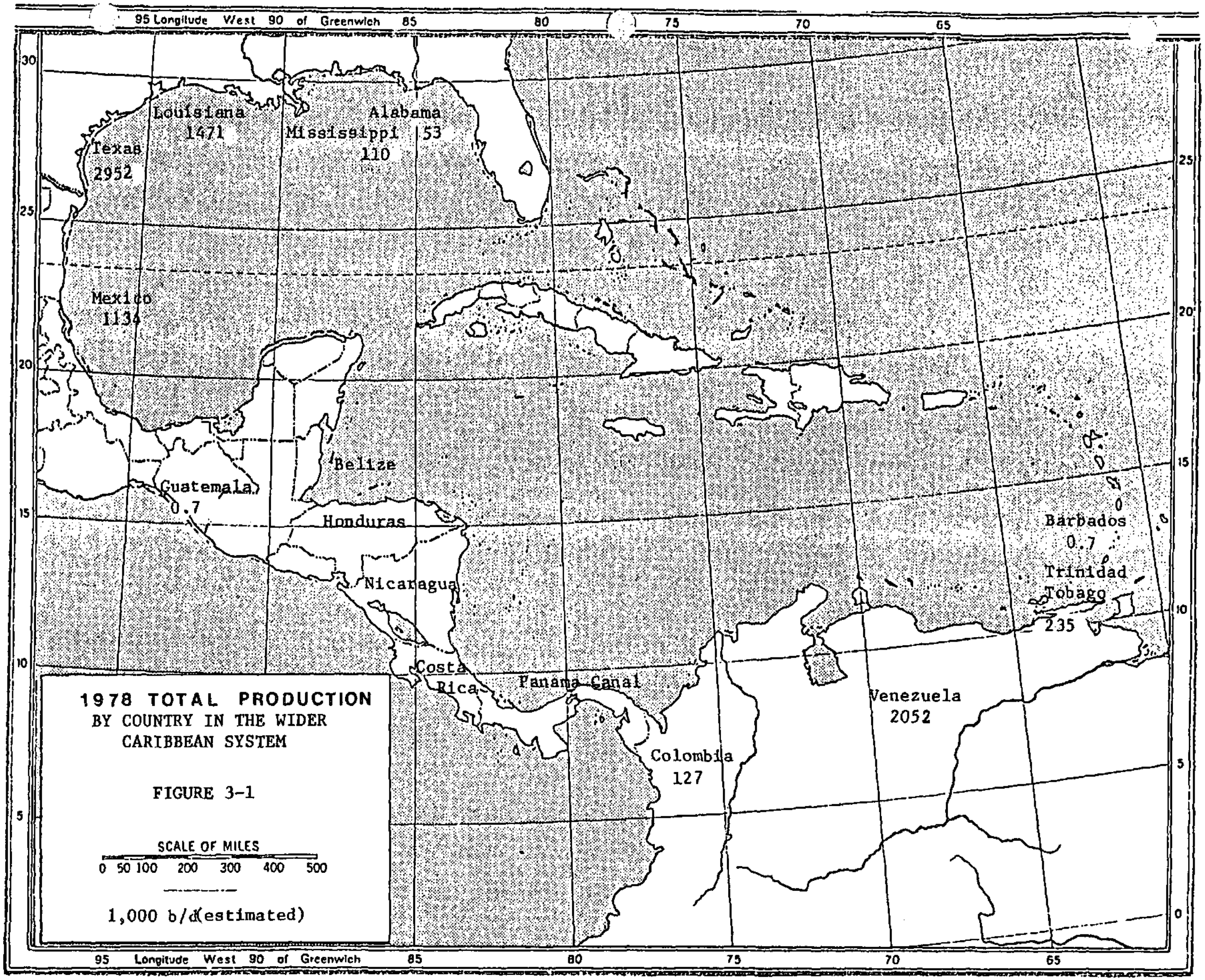
Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
VENEZUELA (cont.)	Inca, '48	7,250	13	...	10	22	5,636	23,346,819	35.8
	Leona, '38	2,200-12,800	20	43	37	150	12,485	154,540,562	24.3
	La Ceiba, '46	9,480	14	...	6	16	4,768	69,888,654	44.0
	Mata, '54	8,970-10,516	40	2	25	334	17,838	473,152,225	34.0
	Merey, '37	5,400-5,700	5	250	...	143	17,467	201,130,117	11.8
	Nipa, '45	6,000-8,500	44	18	70	322	17,781	457,799,162	29.5
	Oscurote, N. 1945	9,513	3	20	11	48	2,805	115,142,702	20.4
	Oficina,'37	5,900	60	138	37	344	31,506	694,265,463	23.5
	Soto, '50	9,500	16	...	21	181	4,024	168,329,225	37.6
	Sta. Ana, '36	8,500	30	...	2	65	6,491	48,346,145	39.8
	San Joaquin,'39	6,550	23	...	...	57	2,730	40,208,666	52.8
	Sta. Rosa, '41	8,500	116	...	17	48	25,460	249,737,830	48.0
	Yopales,'37	4,600	23	45	44	99	15,221	110,549,770	23.8
	Zanjas,'58	13,270	8	...	...	4	4,000	26,723,549	34.1
	Zapatos, '55	11,500	22	...	2	36	8,962	124,748,346	37.6
	Zorro, '53	11,100	8	...	...	18	3,170	63,380,132	25.1
	Zulus, '57	12,710	3	...	2	16	1,352	18,527,770	39.0
	Zumo, '54	9,200	3	7	4	33	1,365	62,342,007	19.0
	La Ceibita,'63	9,878	9	...	...	24	4,767	69,888,654	44.0
	Other	....	84	129	56	573	22,661	500,028,766	29.5
Monagas	Acema, '60	12,530-13,750	38	...	15	49	25,933	21,122,796	24.9
	Aguasay,55	8,100-13,400	9	...	4	46	3,963	98,709,530	39.4
	Jobo, '56	3,600-4,000	1	120	15	88	26,033	122,342,585	12.0

Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
VENEZUELA (cont.)	Morichal, '58	3,312	...	92	...	98	15,322	139,412,291	9.8
	Orocual, '53	2,954	12	8	...	18	1,654	19,365,099	21.1
	Oritupano,'50	7,657	29	56	9	93	18,656	124,930,599	21.5
	Pirital, '58	450-1,100	...	40	...	29	2,113	21,744,254	17.3
	Quiri.,'28	7,000-7,200	...	227	...	237	8,315	741,053,046	16.3
	Sta. Barb.,'41	5,020-6,500	8	14	52	260	2,289	161,552,353	28.4
	Tacat, '53	1,820-3,668	...	51	...	81	2,151	39,803,748	17.3
	Temblador,'36	3,500-4,500	2	1	25	20	2,032	103,723,576	19.4
	Other	....	16	72	8	307	25,575	484,493,193	15.5
Zulia	Barua, '28	3,000	1	...	...	8	767	15,797,933	20.0
	Boscan, '46	6,500-7,500	...	113	...	291	30,285	544,468,762	10.2
	*Bachaqu.,'30	3,440	60	1,266	880	1,112	362,821	5,315,984,080	21.1
	Cruces, Manu. 1916	3,000-8,000	1	44	...	54	3,340	168,204,241	30.6
	*Cabimas, '17	2,200	67	339	173	491	60,200	1,374,915,604	23.7
	Centro, '59	12,568	43	...	66	53	100,329	511,387,277	35.9
	Ceuta, '59	9,600-11,000	16	...	24	110	38,009	271,885,870	28.7
	La Concep., '53	3,148-8,000	3	55	...	107	4,522	122,350,158	35.1
	La Paz, '25	4,268-8,000	16	27	27	77	14,963	804,926,720	31.5
	Lago, '58	11,450	10	...	14	23	30,462	165,464,316	32.0
	*Laguni., '26	3,000	601	1,637	826	1,158	461,879	9,238,658,205	23.6
	Lama, '37	8,320	128	...	67	145	145,710	2,082,249,102	32.6

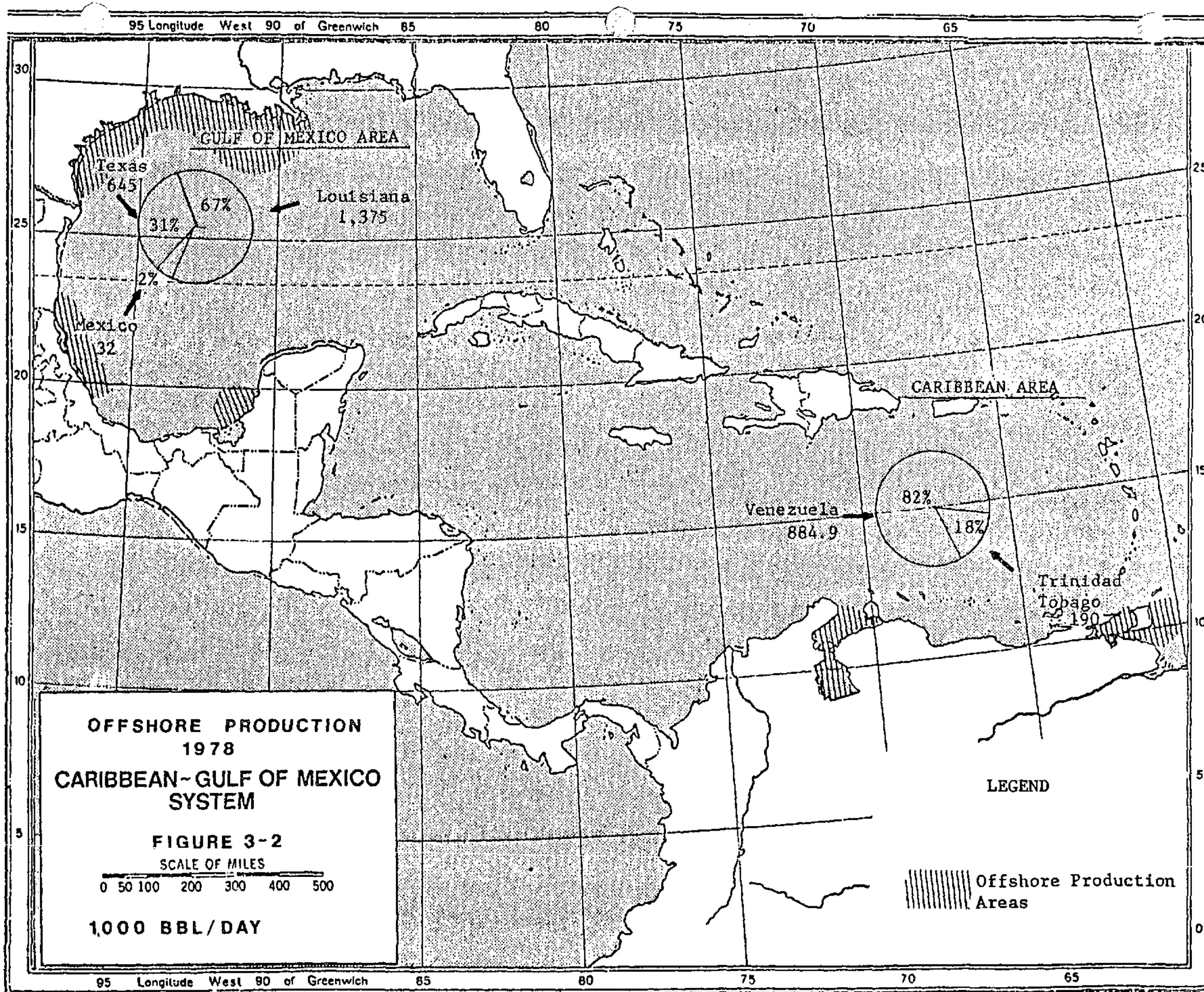
Table 3-2
(cont.)

Production	Name of field Discovery date	depth (ft.)	flow	pump	gas lift	shut in	B/D aver. first 6 mos. 1978	Cumulative bbl 7-1-78	API gravity
VENEZUELA (cont.)									
	Lamar, '58	13,003	44	...	51	61	103,373	848,170,850	34.4
	Mara, '45	5,248	9	1	19	73	5,416	389,018,287	29.7
	Miene Gr., '14	4,132	2	287	...	297	12,498	598,594,850	18.0
	Sibucara,'48	13,451	...	...	1	2	1,082	41,015,427	35.2
	Tia Juana,'28	3,000	89	1,360	276	551	198,626	3,177,761,324	18.8
	West-Tarra	4,250-5,500	7	8	...	25	1,459	66,128,957	39.4
	Other	....	37	17	1	118	27,108	101,449,903	27.6
Barinas	Hato, 1961	9,543	1	8	...	1	2,239	33,313,171	28.0
	Maporal,'57	10,944	...	4	...	1	893	8,804,946	29.2
	Silvan,'49	10,862	1	7	...	...	1,598	39,112,964	29.9
	Silvestre,'48	8,862	1	24	...	14	7,611	118,521,136	25.3
	Sinco, '53	8,500-9,100	1	50	...	30	14,372	221,521,957	23.9
	Other	....	4	30	...	9	8,718	30,903,322	21.1
Falcon Guarico	Budare, '58	4,523	17	1	3	15	8,781	50,271,365	32.1
	Las Merced. '42	4,500	5	4	34	143	1,541	130,185,796	29.6
	Ruiz, '49	4,500	1	1	17	23	698	31,850,931	32.4
	Unknown	....	...	58	...	87	698	106,956,692	....
	Other	....	3	6	18	51	2,824	72,694,980	32.3
Amacuro	Unknown	....	...	...	...	67	57	119,209,686	16.6
	Total	....	1,959	6,776	3,174	9,835	2,051,893	33,975,216,612	....
	Offshore Total							884,900	



1978 TOTAL PRODUCTION
BY COUNTRY IN THE WIDER CARIBBEAN SYSTEM

FIGURE 3-1


OFFSHORE PRODUCTION
1978
CARIBBEAN~GULF OF MEXICO
SYSTEM
FIGURE 3-2
SCALE OF MILES
0 50 100 200 300 400 500
1,000 BBL/DAY
GULF OF MEXICO AREA
Texas
645
67%
31%
2%
Louisiana
1,375
Mexico
32
CARIBBEAN AREA
82%
18%
Venezuela
884.9
Trinidad
Tobago
190
LEGEND
Offshore Production
Areas
95 Longitude West 90 of Greenwich 85 80 75 70 65
30
25
20
15
10
5
0

Oil Refining in the Wider Caribbean Region

Since 1940 the refining capacity of the Caribbean area has increased from .72 to nearly 6.5 million barrels of crude oil per day estimated for 1978. The Gulf Coast crude refineries now have a combined capacity of 5.7 million barrels per day. The refinery capacity of the wider Caribbean region in 1978 is estimated to be over 12 million barrels per day. Table 3-3 lists the refinery capacities of the Caribbean area.

The oil refineries in the region range in size from 1000 barrels per day to 728,000 barrels per day. Table 3-4 is a country by country listing of companies and locations of major refineries including 1977 crude oil runs in barrels per day.

Figure 3-3 shows refinery locations in the region excluding the U.S.A. and Venezuela. The locations of refineries for the Southern United States is included as Figure 3-4. Venezuelan refinery locations are depicted in Figure 3-5.

Table 3-5 summarizes the refineries reported to be under construction in the Caribbean area.

Oil Pollution from Production and Refining

Oil pollution from production includes dramatic spillages, such as, blowouts, platform fires, collection pipeline accidents and spillages associated with natural phenomena such as hurricanes, and chronic pollution in the form of drilling muds, deck drainage from platforms and oil contained in produced formation water which is discharged into the sea.

Gulf of Mexico

The Gulf of Mexico as of 1972 had 13,500 drilled offshore wells. As of that

Table 3-3

CARIBBEAN AND U.S. REFINING CAPACITY*
1950-1979

CARIBBEAN COUNTRIES

top figure = 1000 b/d btm. figure = mill./yr.	1950	1960	1965	1970	1975	1977	1979
Barbados	....	....	3 0.2	3 0.2	3 0.2	3 0.2	3 0.2
Colombia	24 1.2	51 2.5	94 4.6	140 6.9	172 8.5	165 8.6	174 8.7
Costa Rica	....	....	....	8 0.4	11 0.5	8 0.4	12 0.6
Cuba	7 0.4	87 4.3	87 4.3	93 4.6	122 6.0	122 6.0	N.A. ....
Guatemala	....	....	4 ....0.2	21 1.0	26 1.3	14 0.7	14 0.7
Honduras	....	....	....	10 0.5	14 0.7	14 0.7	14 0.7
Jamaica	....	....	26 1.3	28 1.4	33 1.6	33 1.6	33 1.6
Netherlands/Ant.	617 30.4	680 33.5	670 33.0	795 39.2	900 44.4	810 42.1	842 43.8
Nicaragua	....	....	6 0.3	21 1.0	13 0.6	15 0.8	15 0.8
Panama	....	....	55 2.7	140 6.9	100 4.9	100 4.9	100 4.9
Puerto Rico	....	84 4.1	155 7.7	155 7.7	283 14.0	283 14.0	284 14.0
Trinidad & Tobago	104 2.4	182 9.0	345 17.0	417 20.6	461 22.7	461 22.7	461 22.7
Venezuela	254 12.5	886 43.7	1087 53.6	1324 65.3	1532 75.6	1446 75.2	1446 75.2
Virgin Islands	....	....	....	220 10.9	590 29.1	728 35.9	728 35.9
Total	1006 46.9	1970 97.1	2532 123.9	3375 166.6	4260 210.1	4202 213.8	4126 209.0

* Source: 1979 International Petroleum Encyclopedia

Table 3-3

CARIBBEAN AND U.S. REFINING CAPACITY
1950-1979
(cont.)

GULF OF MEXICO COUNTRIES

top figure = 1000 b/d btm. figure = mill./yr.	1950	1960	1965	1970	1975	1977	1979
United States	6,696 330.2	10,400 512.9	10,800 532.7	12,079 595.7	14,845 731.9	15,930 828.4	17,150 857.5
Mexico	160 7.9	357 17.6	461 22.7	515 25.4	760 37.5	935 48.6	1,244 62.2
Total	6,856 338.1	10,757 530.5	11,261 555.4	12,594 621.1	15,605 769.4	16,865 877.0	18,394 919.7

Table 3-4

COUNTRY BY COUNTRY REFINING SURVEY
FOR 1977

All figures are bbl/calendar day

Company and refinery location	Crude	Catalytic cracking	Catalytic reforming
BAHAMAS			
Bahamas Oil Refining Co., Freeport	500,000	....	....
BARBADOS			
Mobil Oil Barbados Ltd., Bridgetown	3,000	....	....
COLOMBIA			
Empresa Colombiana de Petróleos: Barrancabermeja Santander	110,000	35,500 F	
Cartagena	50,000	16,500 F	....
Tibú	5,000	....	....
International Petroleum Colombia Ltd., La Dorada	5,000	....	
Texas Petroleum Co., El Guamo	2,500	....	
Orito	1,000	....	
Total	173,500	52,000	....
COSTA RICA			
Refinadora Costarrincense de Petróleo, Limón	12,000	....	1,500
CUBA			
Total	160,000	....	....
Government-owned refineries at Cabaiguan, Havana, Santiago de Cuba.			
DOMINICAN REPUBLIC			
Falconbridge Dominicana C por A, Bonao	16,461	....	*50
Refinería Dominicana de Petróleo SA, Nigua	30,000	....	9,500
Total	46,461	....	9,550
* To produce hydrogen.			
EL SALVADOR			
Refinería Petrolera Acajutla SA, Acajutla	17,000	....	3,000
GUATEMALA			
Texas Petroleum Co., Escuintla	14,000	....	3,000
HONDURAS			
Refinería Texas de Honduras SA, Puerto Cortes	14,000	....	1,800
JAMAICA			
Esso West Indies Ltd., Kingston	32,600	....	3,000
MARTINIQUE			
Ste. Anonyme de la Raffinerie des Antilles, Fort-de-France	14,000	....	3,100

* Source: 1979 International Petroleum Encyclopedia

All figures are bbl/calendar day

Company and refinery location	Crude	Catalytic cracking	Catalytic reforming
MEXICO			
Petróleos Mexicanos: Atzcapotzalco	105,000	23,000 F	26,000
Cadereyta	100,000	....	....
Madero	185,000	51,000 F	15,000
Minatitlán	275,000	24,000 F 21,000 T	12,000
Poza Rica	38,000	....	5,000
Reynosa	20,500	....	....
Salamanca	200,000	40,000 F 18,000 T	8,000
Salina Cruz	170,000	....	....
Tula, Hidalgo	150,000	40,000 F	30,000
Total	1,243,500	217,000	96,000
NETHERLANDS ANTILLES			
Lago Oil & Transport Co. Ltd., Aruba	480,000	....	....
Shell Curacao NV, Curacao	362,000	42,000	15,000
Total	842,000	42,000	15,000
NICARAGUA			
Esso Standard Oil SA Ltd., Managua	14,900	....	2,800
PANAMA			
Refinería Panamá SA, Las Minas	100,000	....	7,500
PUERTO RICO			
Caribbean Gulf Refining Co., Bayamón	38,000	7,000 F	6,000
Commonwealth Oil Refining Co. Inc. Tallaboa	161,000	40,000 HD	70,000
Yabucoa Sun Oil Co., Yabucoa	85,000	....	....
Total	284,000	47,000	76,000
TRINIDAD AND TOBAGO			
Texaco Trinidad Inc., Pointe-a-Pierre	361,000	26,500 F	20,000
Trinidad and Tobago Oil Co. Ltd. Point Fortin	100,000	....	7,000
Total	461,000	26,500	27,000
VENEZUELA			
Bariven: El Chaure	40,000	....	....
El Toreño	4,500	....	....
Boscanven, Bajo Grande	45,000	....	....
Corporación Venezolana del Petróleo, Morón	20,000	....	1,800
Deltaven, Tucupita	10,000	....	....
Lagoven: Amuay Bay	630,900	....	12,600
Caripito	64,100	....	....
Llanoven, El Palito	105,000	....	7,500
Maraven: Cardon	328,800	38,400 F	....
San Lorenzo	26,900	....	....
Meneven, Puerto la Cruz	165,000	15,000 F	....
Roqueven, San Roque	5,300	....	....
Total	1,445,500	53,400	21,900
VIRGIN ISLANDS			
Hess Oil Virgin Islands Corp., St. Croix	728,000	....	80,000

Table 3-4 (cont.)

UNITED STATES

Survey of operating refineries in the U.S. (state capacities as of January 1, 1979)

State	No. plants	Crude capacity b/cd	Charge capacity, b/sd Cat reforming	Cat hydro-cracking
Alabama	6	130,475	8,500	.....
Alaska	4	85,600	6,000	.....
Arizona	1	6,000	....	.....
Arkansas	4	62,942	5,750	.....
California	39	2,453,620	527,039	328,922
Colorado	3	40,100	11,500	.....
Delaware	1	140,000	42,000	20,000
Florida	1	9,800	....	.....
Georgia	2	22,750	....	.....
Hawaii	2	106,500	11,000	.....
Illinois	12	1,202,000	315,178	66,500
Indiana	8	604,200	109,200	.....
Kansas	11	436,185	110,700	3,000
Kentucky	4	166,470	30,500	.....
Louisiana	25	2,149,950	402,733	78,500
Maryland	2	28,500	....	.....
Michigan	6	143,300	29,600	.....
Minnesota	3	217,800	30,600	.....
Mississippi	6	340,448	95,400	68,000
Missouri	1	109,000	16,000	.....
Montana	6	153,700	45,250	4,900
Nebraska	1	5,600	750	.....
Nevada	1	4,000	....	.....
New Hampshire	1	12,800	....	.....
New Jersey	4	644,000	121,944	.....
New Mexico	9	115,074	17,400	.....
New York	3	135,000	23,000	.....
North Carolina	1	11,900	....	.....
North Dakota	3	61,658	10,200	.....
Ohio	7	589,950	160,700	81,000
Oklahoma	12	555,075	124,347	4,500
Oregon	1	14,000	....	.....
Pennsylvania	10	801,620	221,010	55,000
Tennessee	1	42,500	9,300	.....
Texas	54	4,706,577	1,120,612	136,667
Utah	8	162,425	23,500	1,100
Virginia	1	53,000	9,500	.....
Washington	8	381,400	107,222	39,000
West Virginia	3	19,450	6,160	.....
Wisconsin	1	40,000	10,000	.....
Wyoming	13	194,540	31,894	.....
Total	289	17,169,909	3,794,489	887,089

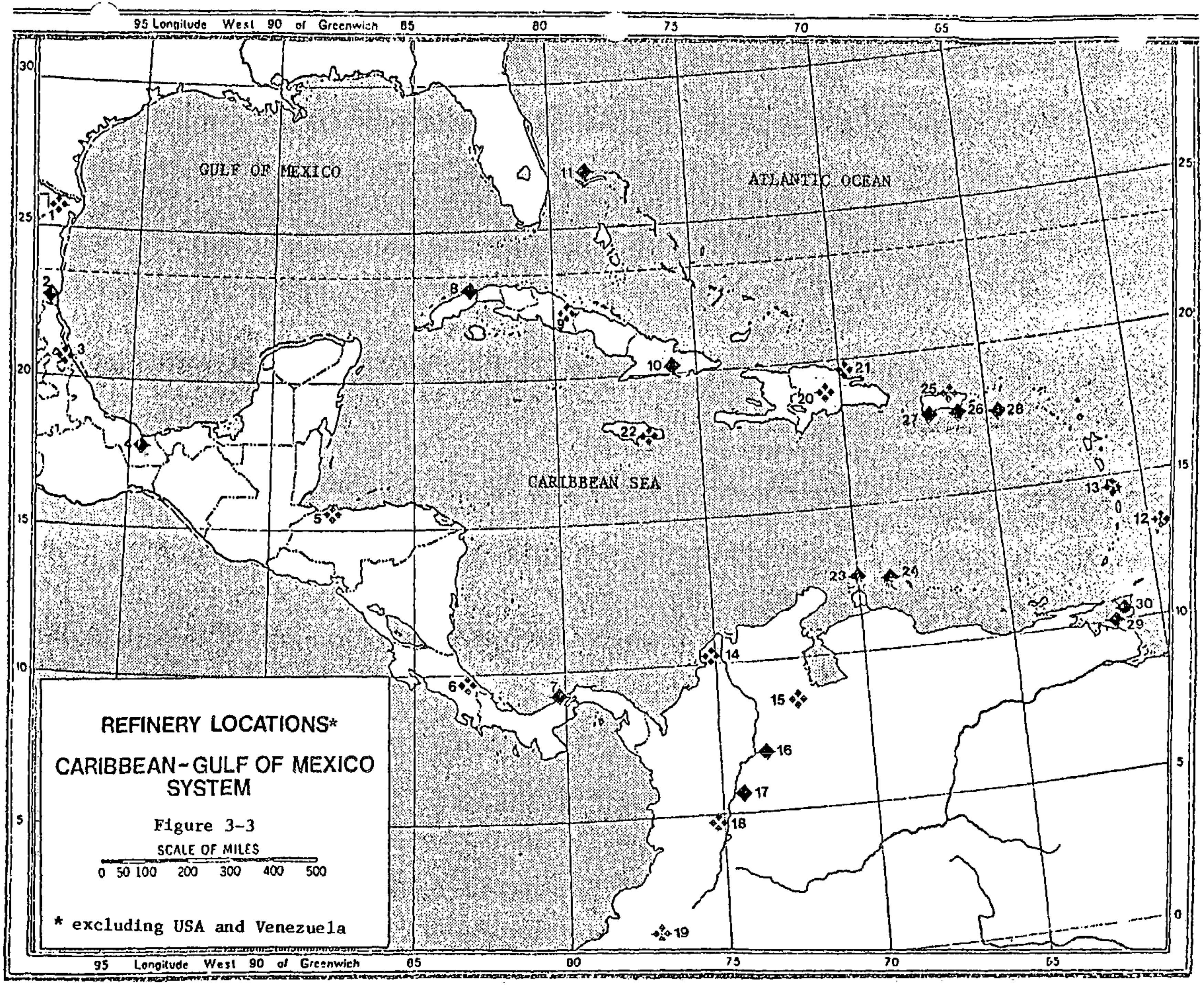
Company and location	Crude capacity b/cd	Charge capacity, b/sd Cat reform-ing	Cat hydro-cracking
ALABAMA			
Hunt Oil Co.—Tuscaloosa	28,500	[2]5,500	...
Louisiana Land & Exploration Co.—Saraland	41,300	......	...
Marion Corp.—Theodore	19,200	[2]3,000	....
Mobil Bay Refining Co.—Chickasaw	28,000	......	....
Vulcan Refining Co.—Cordova	10,600	......	....
Warrior Asphalt Co. of Alabama Inc.—Holt	2,875	......	....
Total	130,475	8,500	....

Company and location	Crude capacity b/cd	Charge capacity, b/sd Cat reform-ing	Cat hydro-cracking
FLORIDA			
Seminole Asphalt Refining Inc.—St. Marks	9,800	......	....
LOUISIANA			
Atlas Processing Co., Division of Pennzoil—Shreveport	45,000	[2]10,000	....
Bayou State Oil Corp.—Hosston	5,000	......	....
Calumet Refining Co.—Princeton	2,400	......	....
Calcasieu Refining Ltd.—Lake Charles	NR	......	....
Canal Refining Co.—Church Point	6,400	[1]2,100	....
Cities Service Co.—Lake Charles	291,000	[2]46,000	....
Claiborne Gasoline Co.—Lisbon	6,500	......	[1]2,200
Continental Oil Co.—Lake Charles	87,000	[2]18,500	....
Cotton Valley Solvents (Kerr-McGee Refining Corp.)—Cotton Valley	11,000	......	....
Evangeline Refining Co. Inc.—Jennings	NR	[3]600	....
Exxon Co.—Baton Rouge	500,000	[3]83,000	[1]25,000
Good Hope Refineries Inc.—Good Hope	86,000	[4]4,500	....
Gulf Oil Corp.—Belle Chasse	195,900	[2]37,500	....
Venice	28,700	[2]18,000	[1]11,500
Hill Petroleum Co.—Krotz Springs	10,100	......	....
LaJet Inc.—St. James	20,000	......	....
Marathon Oil Co.—Garyville	200,000	[5]37,500	....
Mt. Airy Refinery Co.—Mt. Airy	13,600	......	....
Murphy Oil Corp.—Meraux	92,500	[6]23,000	....
Placid Refining Co.—Port Allen	34,200	[2]5,500	....
Shell Oil Co.—Norco	230,000	[2]18,000 [3]28,000	[1]24,000
Shepherd Oil Inc.—Mermentau	10,000	......	....
T & S Refining Inc.—Jennings	10,200	......	....
Tenneco Oil Co.—Chalmette	NR	[2]35,000	[1]18,000
Texaco Inc.*—Convent.	140,000	[2]30,000	....
Total	2,149,950	402,733	78,500

*All figures are calendar day. Stream-day figures not reported.

Table 3-4 (cont.)

Company and location	Crude capacity b/cd	Charge capacity, b/sd — Cat reforming	Charge capacity, b/sd — Cat hydrocracking
MISSISSIPPI			
Amerada-Hess Corp.—Purvis	30,000	5,400	....
Chevron USA Inc.—Pascagoula	280,000	[2]90,000	[1]68,000
Ergon Refining Inc.—Vicksburg	10,000	......	....
Southland Oil Co.—Lumberton	5,725	......	....
Sandersville	10,958	......	....
Yazoo City	3,765	......	....
Total	340,448	95,400	68,000
TEXAS			
Adobe Refining Co.—La Blanca	5,000	......	....
American Petrofina Inc.— Big Spring	60,000	[2]20,000	....
Port Arthur	90,000	[1]22,000	....
Amoco Oil Co.—Texas City	415,000	[4]134,000	[1]42,000
Atlantic Richfield Co.—Houston	363,000	[1]95,000	....
Carbonit Refinery Inc.—Hearne	10,000	......	....
Champlin Petroleum Co.— Corpus Christi	155,000	[2]6,300 [5]25,000	....
Charter International Oil Co.— Houston	65,000	[1]13,500	....
Chevron U.S.A. Inc.—El Paso	76,000	[2]25,000	....
Coastal States Petrochemical Co.— Corpus Christi	185,000	[1]15,000 [6]20,000	....
Crown Central Petroleum Corp.— Houston	100,000	[1]8,000 [2]14,000	....
Diamond Shamrock Corp.—Sunray	51,500	[2]14,000	....
Dorchester Refining Co.— Mt. Pleasant	26,000	[2]4,000	....
White Deer	NR	[2]1,000	....
Eddy Refining Co.—Houston	NR	......	....
Erickson Refining Co.—Port Neches	30,000	......	....
Exxon Co. U.S.A.—Baytown	640,000	[3]88,000 [4]60,000	[1]21,000
Flint Chemical Co.—San Antonio	1,200	......	....
Gulf Oil Co.—Port Arthur	334,500	[2]65,000	[1]15,000
Gulf States Oil & Refining Co.— Corpus Christi	12,500	......	....
Howell Corp.—Corpus Christi	15,000	[2]9,500	[1]5,000
San Antonio	3,000	[2]1,300	....
Independent Refining Corp.—Winnie	16,000	[1]5,000 [2]2,700	[1]3,000
LaGloria Oil & Gas Co.—Tyler	29,300	[2]9,500	....
Longview Refining Co., Division of Crystal Oil Co.—Longview	8,827	[2]5,500	....
Marathon Oil Co.—Texas City	66,000	[1]8,000	....
Mobil Oil Corp.—Beaumont	325,000	[2]102,000	[1]29,000
Phillips Petroleum Co.—Borger	97,000	[1]7,500 [2]21,000	....
Sweeny	97,000	[2]36,000	....
Pioneer Refining Ltd.—Nixon	4,900	......	....
Pride Refining Inc.—Abilene	20,500	......	....
Quintana Refinery Co.— Corpus Christi	15,000	[2]9,500	[1]5,000
Quitman Refining Co.—Quitman	6,000	......	....
Rancho Refining Co. of Texas—Donna	1,200	......	....
Saber Refining Co.—Corpus Christi	20,000	......	....
Sector Refining Co.—Tucker	9,700	......	....
Sentry Refining Inc.—Corpus Christi	10,000	......	....
Shell Oil Co.—Deer Park	285,000	[2]28,000 [3]40,000	....
Odessa	32,000	[1]11,000	....
Sigmor Refining Co.—Three Rivers	22,800	[2]8,500	....
South Hampton Refining Co.—Silsbee	20,500	[2]4,000	....
Southwestern Refining Co. Inc.— Corpus Christi	120,000	[2]30,000	....
Sun Co. Inc.—Corpus Christi	57,000	[1]13,000 [3]11,000	....
Tesoro Petroleum Corp.— Carrizo Springs	26,100	[2]3,000	....
Texaco*—Amarillo	20,000	[2]5,000	....
El Paso	17,000	[2]3,500	....
Port Arthur	406,000	[2]60,000	[1]15,000
Port Neches	47,000	......	....
Texas Asphalt & Refining Co.— Euless	5,000	......	....
Texas City Refining Inc.— Texas City	119,600	[2]11,000	....
Thriftway Inc.—Graham	1,800	......	....
Tipperary Corp.—Ingleside	6,500	......	....
Uni Refining Inc.—Ingleside	NR	......	....
Union Oil Co. of California— Beaumont	120,000	[3]36,000	....
Winston Refining Co.—Fort Worth	20,000	[1]1,700	....
Total	4,706,517	1,120,612	136,667



REFINERY LOCATIONS*

CARIBBEAN – GULF OF MEXICO SYSTEM

Figure 3-3

* excluding USA and Venezuela

LEGEND TO FIGURE 3-3

Number	Location	1977 Crude Run
1.	Reynosa, Mexico	20,500 b/d
2.	Madero, Mexico	185,000 b/d
3.	Poza Rica, Mexico	38,000 b/d
4.	Minatitlan, Mexico	270,000 b/d
5.	Puerto Cortes, Honduras	14,000 b/d
6.	Petroleo, S.A. Limon, Costa Rica	10,000 b/d
7.	Refineria Panama, S.A. Las Minas, Panama	100,000 b/d
8.	Havana, Cuba	75,000 b/d
9.	Cabaiguan, Cuba	4,000 b/d
10.	Santiago de Cuba	73,000 b/d
11.	Bahamas Oil Refining Co., Freeport, Bahamas	500,000 b/d
12.	Mobil Oil Barbados, Ltd. Bridgetown, Barbados	3,000 b/d
13.	Fort de France, Martinique	11,900 b/d
14.	Cartagena, Colombia	48,000 b/d
15.	Tibu, Colombia	2,500 b/d
16.	Barrancabermeja, Colombia	106,000 b/d
17.	La Dorada, Colombia	5,000 b/d
18.	El Guamo, Colombia	2,500 b/d
19.	Orito, Colombia	1,000 b/d
20.	Bonao, Dominican Republic	16,461 b/d
21.	Nigua, Dominican Republic	30,000 b/d
22.	Kingston, Jamaica	32,600 b/d
23.	Aruba, Netherlands Antilles	480,000 b/d
24.	Curacao, Netherlands Antilles	362,000 b/d
25.	Bayamon, Puerto Rico	38,000 b/d
26.	Yabucoa, Puerto Rico	85,000 b/d
27.	Penuelas, Puerto Rico	
28.	St. Croix, Virgin Islands	728,000 b/d
29.	Point Fortin, Trinidad	100,000 b/d
30.	Point a Pierre, Trinidad	261,000 b/d

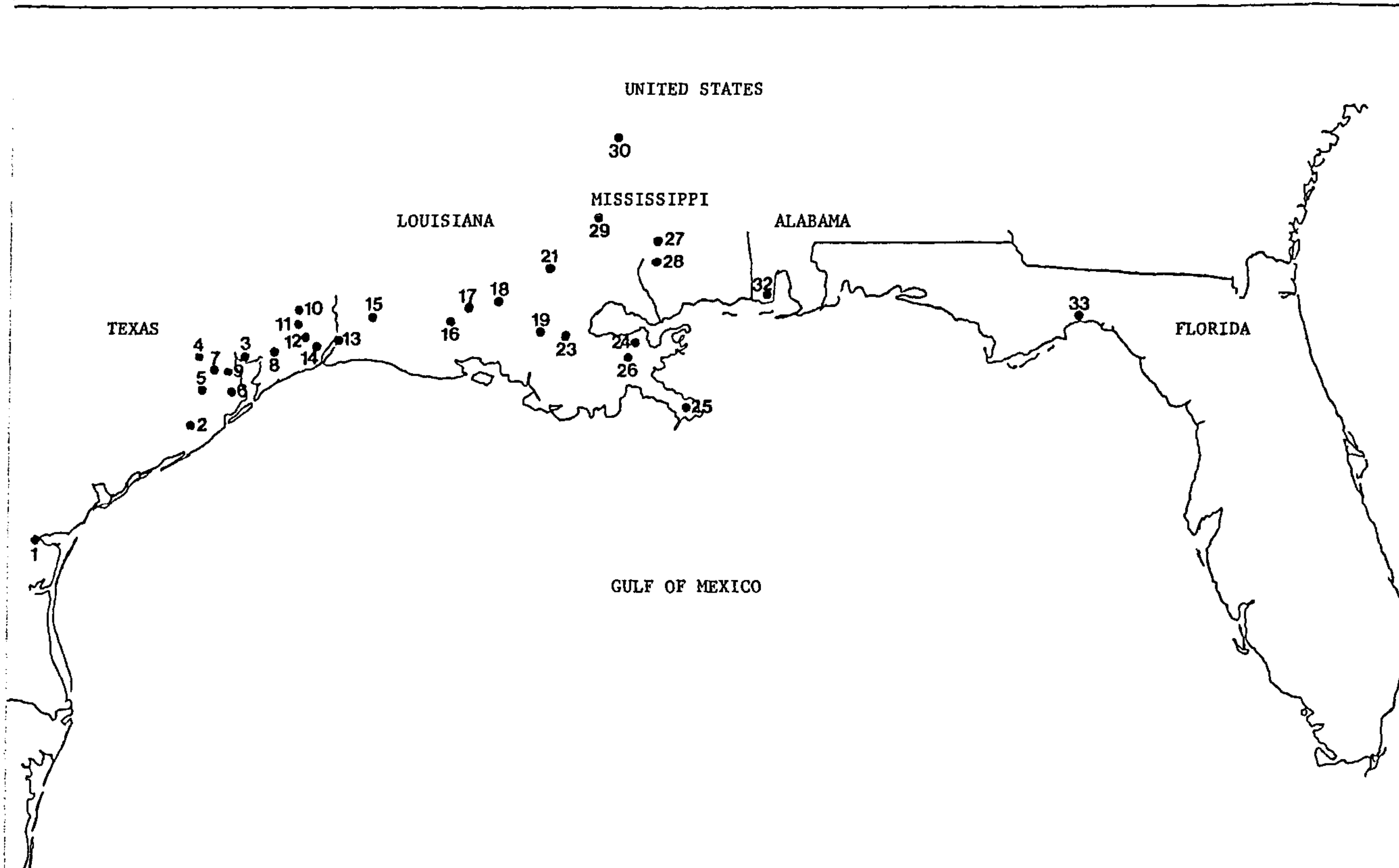


Figure 3-4

SOUTHERN UNITED STATES
REFINERY LOCATIONS

LEGEND

Scale: 1:2,160,000

REFINERY LOCATIONS — Barrels per Calendar Day

1. Corpus Christi - 344,686
2. Sweeny - 85,000
3. Baytown - 500,000
4. Houston - 288,410
5. Alvin - 8,500
6. Texas City - 470,200
7. Pasadena - 100,000
8. Winnie - 9,400
9. Deer Park - 294,000
10. Silsbee - 29,600
11. Nederland - 116,000
12. Port Arthur - 1,188,000
13. Port Neches - 47,000
14. Beaumont - 335,000
15. Lake Charles - 268,000
16. Jennings - 4,000
17. Egan - 15,000
18. Church Point - 3,500
19. St. James - 11,000
20. Norco - 240,000
21. Baton Rouge - 458,000
22. Chalmette - 97,500
23. Convent - 140,000
24. Meraux - 92,500
25. Venice - 28,700
26. Belle Chasse - 180,400
27. Purvis - 28,500
28. Lumberton - 5,500
29. Sandersville - 11,000
30. Yazoo City - 4,500
31. Pascagoula - 240,000
32. Theodore - 17,500
33. St. Marks - 5,000

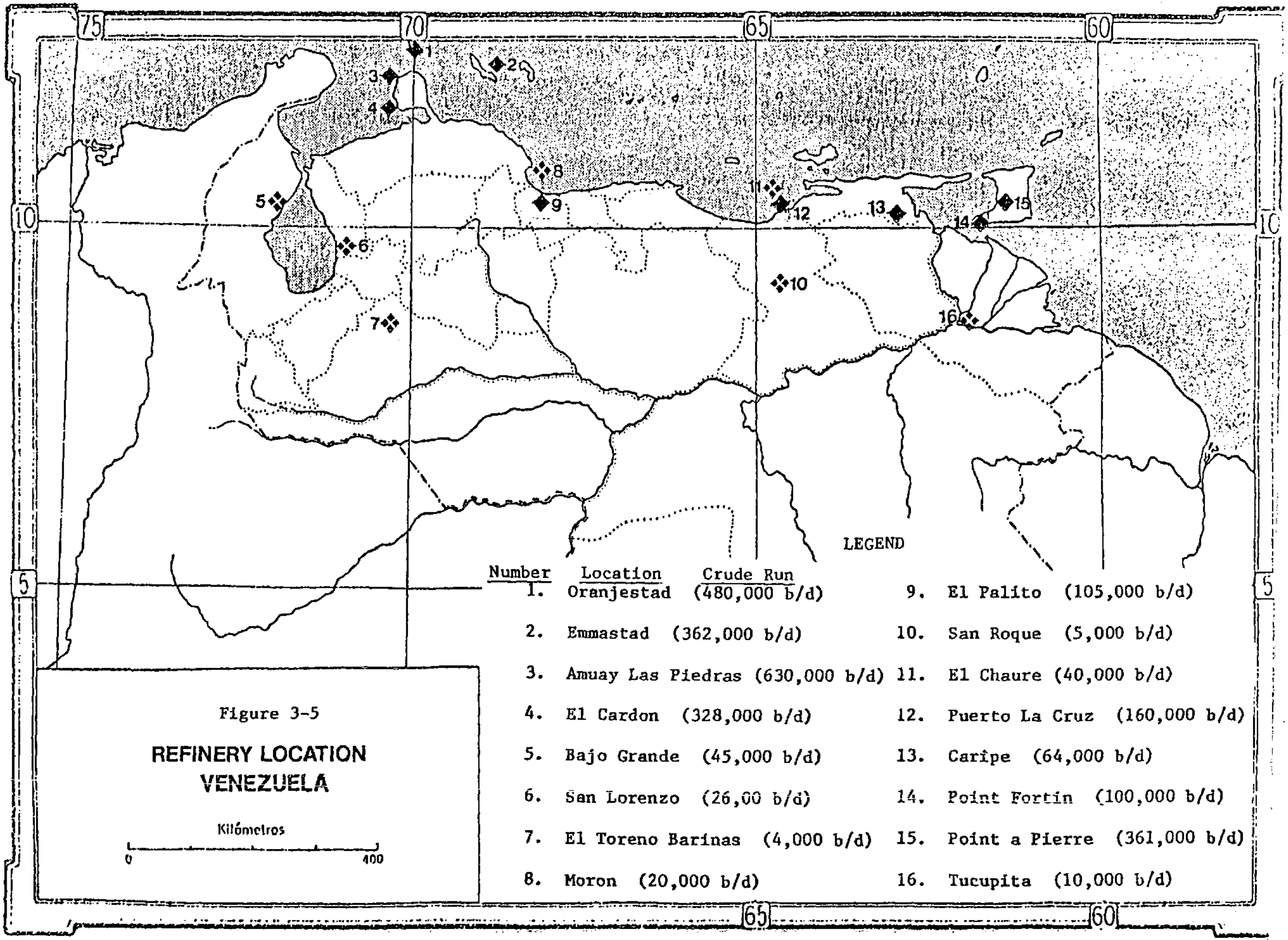


Figure 3-5

REFINERY LOCATION VENEZUELA

Number	Location	Crude Run
1.	Oranjestad	(480,000 b/d)
2.	Emmastad	(362,000 b/d)
3.	Amuay Las Piedras	(630,000 b/d)
4.	El Cardon	(328,000 b/d)
5.	Bajo Grande	(45,000 b/d)
6.	San Lorenzo	(26,00 b/d)
7.	El Toreno Barinas	(4,000 b/d)
8.	Moron	(20,000 b/d)
9.	El Palito	(105,000 b/d)
10.	San Roque	(5,000 b/d)
11.	El Chaure	(40,000 b/d)
12.	Puerto La Cruz	(160,000 b/d)
13.	Caripe	(64,000 b/d)
14.	Point Fortin	(100,000 b/d)
15.	Point a Pierre	(361,000 b/d)
16.	Tucupita	(10,000 b/d)

Table 3-5

REFINERIES UNDER CONSTRUCTION*

COUNTRY	TYPE	LOCATION	CAPACITY	(BBL/day)
Colombia	Crude	Barrancabermeja	135,000	(1979)
		Cartagena	67,200	(1980)
		Total	192,000	
Costa Rica	?	?	?	
Jamaica	?	Luana Point	80,000	
Mexico	Crude	Cadereyta	135,000	
St. Lucia	?	St. Lucia	150,000	
Venezuela	?	Lake Maracaibo	200,000	
		Zulia	300,000	
		Total	500,000	

* Source: 1978 International Petroleum Encyclopedia

time there were reported 10 major mishaps of spilled oil including submarine pipeline incidents.

In 1972 there were 2,408 platforms located in U.S. waters in the Gulf of Mexico, and an additional 4,105 production platforms in the bays of Texas and Louisiana. This number has increased since that time and are joined by an increasingly large offshore production in Mexico. In 1978, 44 wells were reported offshore in northern Mexico and an additional 12 platforms and rigs were observed in 1979 in the Gulf of Campeche area.

A summary of U.S. offshore Continental Shelf Gulf of Mexico spills of 50 barrels or more for 1966-1975 are included as Table 3-6 Pipeline incidents, blowouts, platform fires, and natural phenomena oil spills are listed. Spill volume and year the spill took place is listed for each spill. There are 48 spills listed that occurred over the nine year period. The average spill volume of the six largest spills of over 500 barrels caused by blowouts, platform fires, overflows, malfunctions is 29,700 barrels. Therefore, this size spill would be expected to occur twice every three years.

A condensed summary of 1978 oil spills related to refining, production and pipelines in the wider Caribbean region is listed in Table 3-7. Included for each incident is the source, location, spill volume, type of oil and cause, if known.

As of the time of the writing of this report, the world's largest reported blowout is occurring from Mexico's IXTOC I well, 90 miles NNW of Ciudad del Carmen in the Bay of Campeche. If reported discharge rates of 30,000 BBL/day are correct, this spill has now exceeded the size of the Amoco Cadiz spill of 223,000 tons and hope of stopping the blowout appears several months away when relief wells are completed and the hole sealed.

Table 3-6

Summary of U.S. OCS oil spills of at least 50 barrels, 1966–1975

	USGS Spill Reference No.	Year	Volume Spilled (Bbl)
Pipeline Accidents			
Gulf of Mexico	8	1967	65
	9	1967	160,639
	11	1968	6,000
	12	1969	100
	13	1969	342
	14	1969	7,532
	18	1969	50
	24	1970	50
	35	1971	70
	37	1971	80
	39	1972	100
	42	1973	5,000
	44	1974	19,833
	45	1974	100
Pacific Coast	2	1969	900
Total			200,861 (15 spills)
Blowouts			
Gulf of Mexico	16	1969	2,500
Total			2,500 (1 spill)
Platform Fires			
Gulf of Mexico	21	1970	30,500
	23	1970	100
	26	1970	53,000
	34	1971	450
Total			84,050 (4 spills)
Natural Phenomena (Hurricanes, Earthquakes, etc.)			
Gulf of Mexico	47	1974	75
	48	1974	2,213
Total			2,288 (2 spills)
Platform Overflows & Malfunctions			
Gulf of Mexico	10	1968	85
	15	1969	250
	17	1969	100
	19	1969	50
	20	1970	228
	22	1970	50
	25	1970	395
	27	1971	200
	28	1971	50
	29	1971	50
	30	1971	50
	31	1971	135
	32	1971	100
	33	1971	50
	36	1971	50
	38	1972	50
	40	1973	9,939
	41	1973	7,000
	43	1973	240
	46	1974	130
	49	1974	50
	50	1974	120
	51	1974	200
	52	1975	166
	53	1975	100
Total			19,838 (25 spills)

Source: USGS, 1975, Accidents Connected with Federal Oil and Gas Operations on the Outer Continental Shelf, Dept. of the Interior, Washington, D.C.

Table 3-7

SUMMARY OF 1978 OIL SPILLS
Due to Refining, Production and Pipelines

DATE	SOURCE	LOCATION	GALLONS SPILLED	TYPE OF OIL	CAUSE
1 Feb	refinery Texaco, Inc.	(30°00' N, 90°03' W) (New Orleans, Louisiana)		undetermined	explosion & fire
6 Jan	refinery Marathon Oil Co.	29°23' N, 94°55' W Texas City, Texas		undetermined	fire
28 Feb	storage depot	30°20' N, 81°40' W Jacksonville, Florida		undetermined	fire
30 May	refinery Texas City Refinery Co.	29°23' N, 94°55' W Texas City, Texas	up to 110,000	petroleum products	explosion & fire
29 Jun	storage tank Standard Oil Co. (Indiana)	30°24' N, 88°15' W Bayou La Batre, Alabama	up to 34,000	lubrication	• fire • lightning
25 Jul	refinery Crown Central Petroleum Corp.	29°42' N, 95°14' W Pasadena, Texas		solvent	• explosion & fire • lightning
10 Sep	platform drilling rig Reading & Bates Oil & Gas Co.	off Louisiana in Gulf of Mexico		undetermined	blow-out & fire
21 Sep	U.S. Strategic Petroleum Reserve	(29°59' N, 93°20' W) West Hackberry, Louisiana	2,835,000	light Arabian crude	• blow-out & fire • plug failure
12 Oct	oil field Gulf Oil Corp.	29°16' N, 89°23' W Venice, Louisiana	25,000	crude	pipeline puncture
11 Dec	pipeline Amoco Transport Co.	29°23' N, 94°55' W Texas City, Texas	21,000	medium crude	pipeline rupture
14 Dec	storage tank Commonwealth Oil Refining Co.	(18°00' N, 66°35' W) Benuelan, Puerto Rico	10,500,000	No. 6 fuel	tank rupture
24 Dec	tank Clarco Pipeline Co.	30°31' N, 91°12' W Scotlandville, Louisiana	3,400,000	crude	fire

OIL SPILL INTELLIGENCE REPORT / 23 MARCH / 1979

Predicting future production related spillages is not an easy task but at least the location is better defined than for shipping spills.

A recent analysis made by the U.S. Coast Guard predicted that major spills of 1,200 barrels (50,000 gallons) or more per year could be calculated by the formula .027 V per million tons where V is the total production in million tons/year.

Using this formula based on U.S. production, experience would yield the following rates for the wider Caribbean countries:

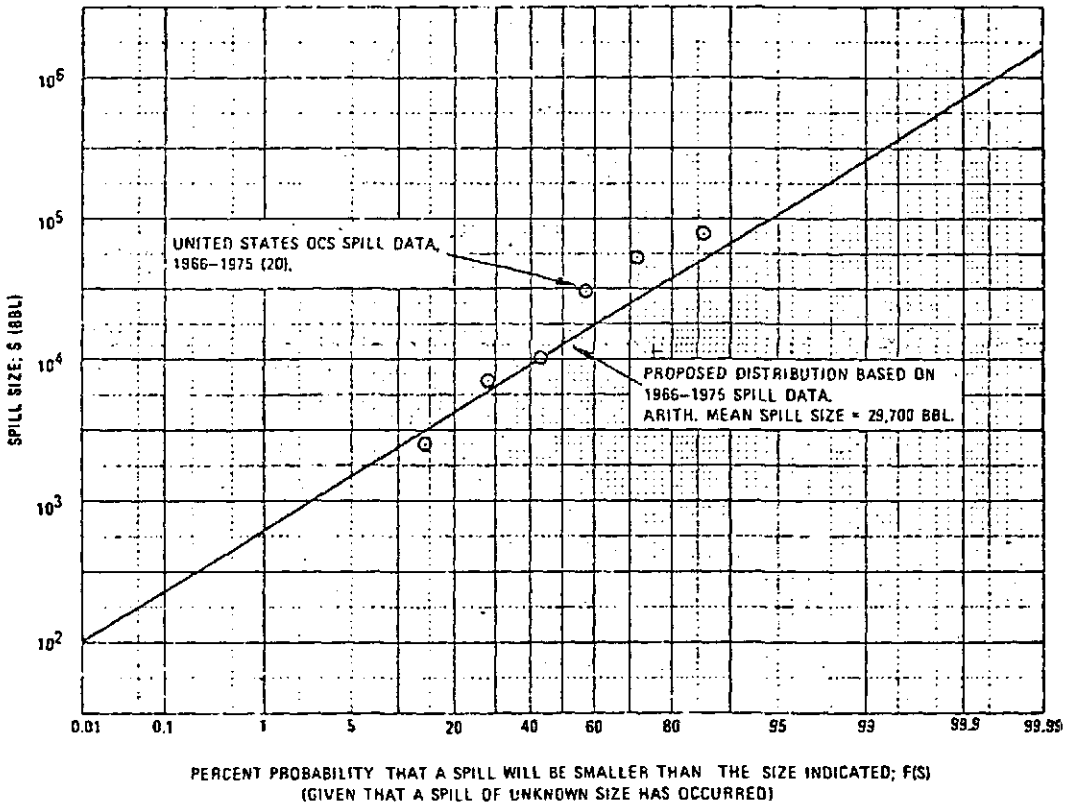
	million tons/year	accidents/year
United States		
Texas	33.6	.91
Louisiana	71.7	1.93
Mexico	1.6	.04
Trinidad and Tobago	9.9	.26
Venezuela	46.1	1.25
Total Wider Caribbean		4.39

This would indicate between 4 and 5 major spills over 1,200 barrels in the wider Caribbean each year.

Data is not available to predict whether a higher (or lower) rate should be applied for Mexico, Trinidad and Tobago or Venezuela, based on local production practices.

An Analysis of Spill Size Versus Probability for a Major Spill of Unknown Size Based on U.S. Offshore Continental Shelf Production Experience

Table 3-8 shows past experience in total spill volume from offshore platforms. Based on these figures, the expected offshore losses from platforms would be as shown in Table 3-9.



Cumulative size distribution for major drilling and platform-related spills from OCS operations, 1966–1975

Table 3-8

Historical Parameters for predicting OCS petroleum development spills

Spill Category	Prediction Parameters for Exposure Variables of: Volume of Oil and Condensate Produced*	Number of Wells Drilled
Pipeline Accidents	13 BP$\overline{M}$B[a]	-
Blowouts	24 BP$\overline{M}$B[b]	12 Bbl/Well[c]
Natural Phenomena	0.7 BP$\overline{M}$B[b]	-
Platform Fires	26 BP$\overline{M}$B[b]	-
Platform Overflows and Malfunctions	6.1 BP$\overline{M}$B[b]	-
Minor Spills (50 bbl each)	2.5 BP$\overline{M}$B[d]	-

(a) Based on reported spillage (Table 5) and on U.S. OCS oil and condensate production (1,916 $\overline{M}$ bbl), 1971 through 1975.

(b) Based on reported spillage (Table 5) and on U.S. OCS oil and condensate production (3,269 $\overline{M}$ bbl), 1966 through 1975.

(c) Based on reported spillage (Table 5) and on 6,319 wells drilled on the U.S. OCS, 1966 through 1975.

(d) Based on 4,824 bbl released in 5,830 spills on the U.S. OCS, 1971 through 1975. Oil and condensate production during that period was 1,916 $\overline{M}$ bbl.

* BPMB - barrels per million barrels

Table 3-9

EXPECTED ANNUAL OFFSHORE OIL SPILLS IN THE WIDER CARIBBEAN AREA

Location	million tons/yr	million BBL/yr	Pipeline accidents	Blowouts	Natural Phenomena	Platform fires	Platform overflows & malfunctions	Minor Spills	TOTAL
SPILL VOL./ mill. BBL			13	24	.7	26	6.1	7.5	77.3
U.S.									
Texas	34	235	3,058	5,645	165	6,115	1,435	1,764	18,451
Louisiana	72	502	6,525	12,046	351	13,049	3,062	3,764	39,371
MEXICO	2	11	146	269	8	291	68	84	879
TRINIDAD & TOBAGO	10	69	901	1,662	49	1,802	423	520	5,436
VENEZUELA	46	323	4,195	7,745	226	8,390	1,968	2,420	89,450
TOTAL	164	1,140	14,825	27,367	799	29,647	6,956	8,552	

Chronic Discharge

Discharge of a chronic nature from platforms and refineries may be significant in local areas where adequate control is not maintained. Figure 3-6 shows the distributed pollution for volatile liquid hydrocarbons (VLH) in the Gulf of Mexico system. The diagram includes oil fraction discharge from river runoff, chronic platform discharges, chronic spill discharges, and atmospheric discharges as well as other factors. Table 3-10 quantifies these total releases into the environment for the Gulf of Mexico. Extrapolation to other areas of the Caribbean should include an estimate of the relative level of release based on local experience.

Figure 3-6

VOLATILE LIQUID HYDROCARBONS

VLH MASS FLOW IN THE GULF OF MEXICO

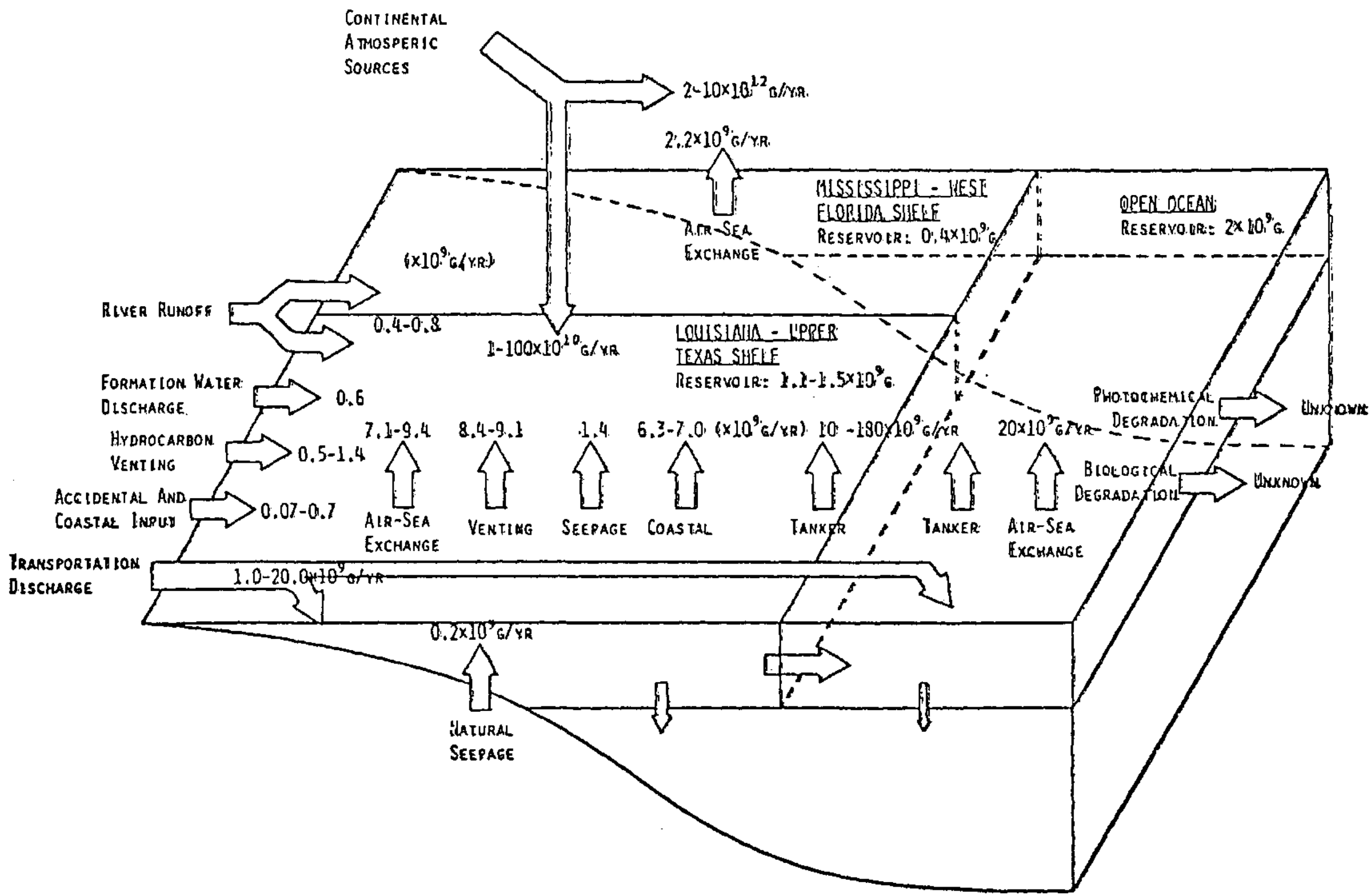


TABLE 3-10

Summary of the non-atmospheric VLH inputs into the waters of the Gulf of Mexico.

	Dissolved in water column 1000 metric tons/yr	Released to Atmosphere 1000 metric tons/yr
OFFSHORE PRODUCTION		
Hydrocarbon Venting		
VLH	0.5-1.4	8.2-9.1
Gaseous HC	19-57	323-361
Formation Water		
VLH (continental shelf)	0.28	-
VLH (coastal and shelf)	0.60	-
Gaseous HC	0.04	-
$>C_{14}$ (50 ppm, shelf)	1.0	
RIVER DISCHARGE		
Mississippi River (8.4×10^{14} l/yr)		
VLH (0.5-1.0 μg/L)	0.42-0.84	-
Methane (2000 nl/L)*	1.2	-
C_2-C_4 (100 nl/L)*	0.17	-
COASTAL INPUTS		
VLH	0.07-0.7	6.3-7.0
TANKER DISCHARGES		
Petroleum tankers		
VLH	1.5-20.0	13.5-180.0
Chemical tankers		
VLH	0.38	3.42
NATURAL SEEPAGE		
VLH	0.24	1.36
Methane*	75	425
C_2-C_4*	2.4	13.6

*Adapted from Brooks (1975)

SECTION 4

OIL TRANSPORTATION IN THE WIDER CARIBBEAN REGION

Crude Oil Movement

Prior to 1973 major oil shipping in the wider Caribbean region was the export of the United States, Venezuela and Trinidad and Tobago oil through the Caribbean and Gulf of Mexico to the east coast of the United States, to European and other foreign markets. Figure 4-1 shows an estimate of oil movement in the region circa 1960's.

Increased United States demand for foreign oil to offset declining production and continued economic growth, the growth of the supertanker, and the world energy situation have drastically altered this shipping pattern.

The wider Caribbean now serves three major oil transportation activities:

1. The pathway for the transport of Persian Gulf, West African, and North African crude oil to the United States usually by supertanker with a stop for refining, transhipping or lightering and subsequent transport by smaller vessels to the U.S. coast.
2. The pathway for shipping either crude or refined products from Venezuela and/or Aruba, Curacao to various world markets.
3. The shipping of Alaskan crude oil through the Panama Canal to the U.S. Gulf Coast, the Virgin Islands or U.S. east coast refineries.

In the future the transport of crude oil or refined products from Mexico may become another major pathway.

In addition to the major pathways, the Caribbean serves for the transport of both crude oil and refined products to the many user countries in the wider Caribbean area.

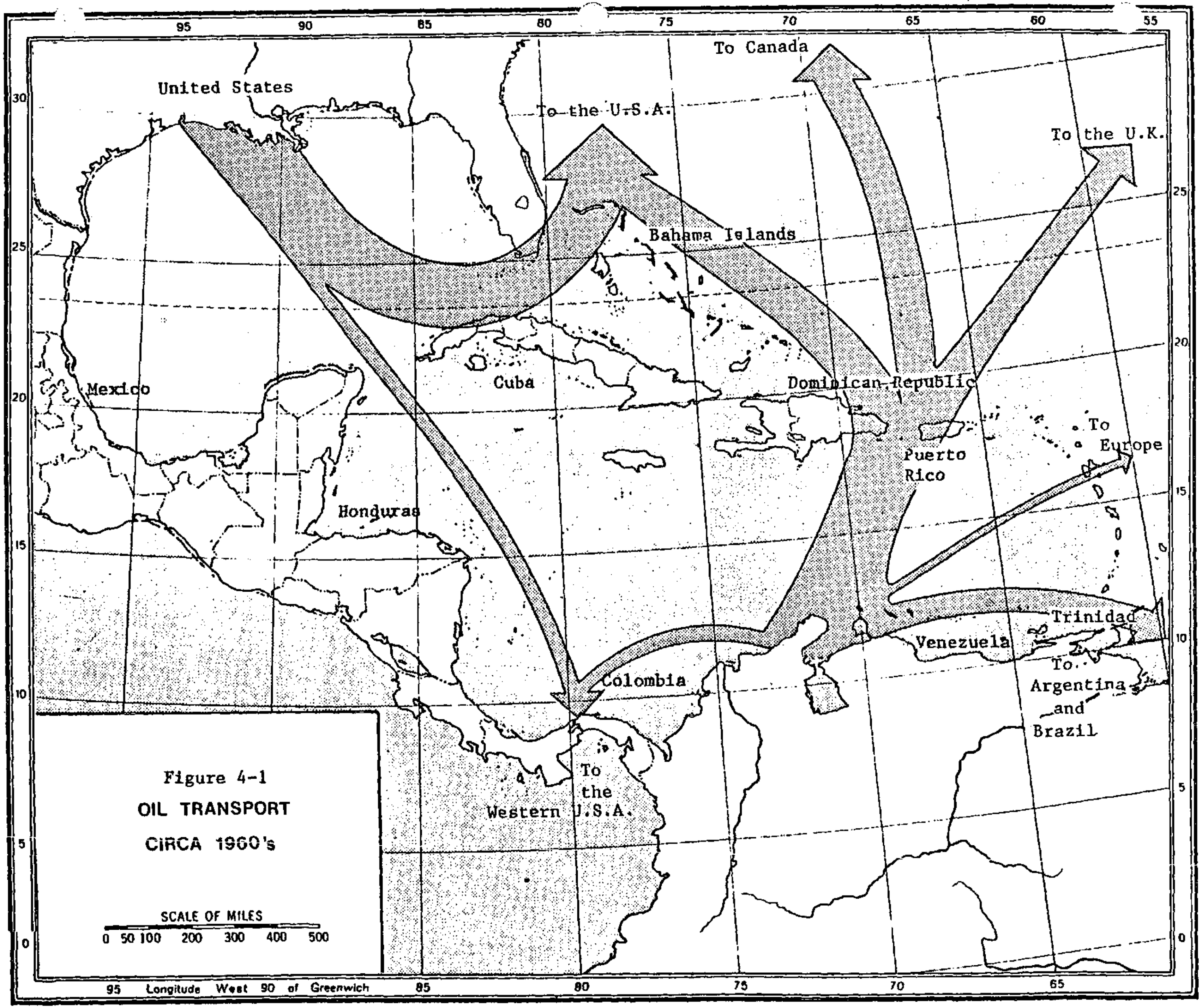


Figure 4-1
OIL TRANSPORT
CIRCA 1960's

In order to gain as good a view as possible of the oil and oil product transportation paths in the wider Caribbean, this section will first address the reported import and export figures for each country.

Special attention will then be focused on the crude oil transported through the Panama Canal and the exports from Venezuela and Trinidad and Tobago because relatively good figures exist for the components of the oil picture and the pathways of shipment are relatively clear. Determining the total flow of crude oil through the Caribbean and Gulf has been difficult because statistics are not generally available for the route of the U.S. imports to individual U.S. port areas. However, data furnished by some of the companies operating in the area are used in the report to provide the best guess possible of the Caribbean-Gulf of Mexico throughput.

Attention is then directed to the various ports, transhipping terminals and lightering points used in the Gulf and the Caribbean.

The last part of the section addresses the oil pollution arising from oil transported, including collisions, groundings, strandings and explosions, loading and unloading accidents, tankwashing, ballast water discharge, and bilge water.

Information on past accidental spills in the region are presented and a rough analysis of potential spill rates is presented.

Import/Export Analysis

Annual crude oil imports and exports by origin and destination in the wider Caribbean area, as presented in the Yearbook of International Trade Statistics are presented in Table 4-1. The exports and imports for 1976 and 1977 are included as reported by the exporting and importing country. All units are in terms of metric tons. Discrepancies in reported

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN*

I = exports to the importer reported by exporter
E = imports from the exporter reported by the importer
(all values in metric tons)

ORIGIN:	DESTINATION:	1976	1977
Algeria	U.S.A./Puerto Rico	20,700,757 E 20,427,015 I	26,773,693 E No Data I
Bahamas	United Kingdom	45,232 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	1,455,961 E No Data I	No Data E No Data I
Brunei	U.S.A./Puerto Rico	368,168 E No Data I	210,521 E No Data I
Canada	U.S.A./Puerto Rico	23,493,881 E 25,210,087 I	15,888,057 E 16,683,333 I
Ecuador	Netherlands Antil les	589,000 E No Data I	No Data E No Data I
"	Trinidad	205,109 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	2,930,739 E No Data I	2,754,809 E No Data I

*Source: Yearbook of International Trade Statistics 1977, Volume II

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Gabon	Bahamas	No Data E	No Data E
		1,312,820 I	No Data I
"	Netherlands Antilles	603,000 E	1,709,690 E
		137,616 I	No Data I
"	U.S.A./Puerto Rico	1,769,959 E	No Data E
		1,802,259 I	No Data I
Indonesia	Trinidad	3,130,764 E	No Data E
		5,906,025 I	No Data I
"	U.S.A./Puerto Rico	25,822,836 E	26,179,985 E
		21,744,289 I	No Data I
Iran	Netherlands Antilles	511,000 E	No Data E
		No Data I	No Data I
"	Trinidad	2,276,951 E	No Data E
		No Data I	No Data I
"	U.S.A./Puerto Rico	15,487,132 E	28,338,601 E
		No Data I	No Data I
Iraq	Trinidad	34,173 E	No Data E
		No Data I	No Data I

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN	DESTINATION:	1976	1977
Iraq	U.S.A./Puerto Rico	1,224,658 E No Data I	3,957,698 E No Data I
Kuwait	Trinidad	94,359 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	89,339 E No Data I	2,044,048 E No Data I
Libyan Arab Jamahiriyia	U.S.A./Puerto Rico	23,264,420 E 25,381,943 I	35,340,124 E No Data I
Malaysia	U.S.A./Puerto Rico	864,215 E 1,363,570 I	No Data E No Data I
Mexico	Brazil	No Data E 48,094 I	No Data E No Data I
"	Canada	36,377 E No Data I	No Data E No Data I
"	Netherland Antilles	494,000 E 544,008 I	No Data E No Data I
"	U.S.A./Puerto Rico	4,615,503 E 5,000,904 I	8,778,772 E No Data I

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN	DESTINATION	1976	1977
Nigeria	Netherlands Antilles	1,055,000 E 9,735,108 I	No Data E No Data I
"	Trinidad	127,122 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	50,214,410 E 34,331,160 I	56,515,655 E No Data I
Norway	U.S.A./Puerto Rico	2,699,692 E No Data I	3,295,736 E No Data I
Oman	Netherlands Antilles	136,000 E 1,381,000 I	No Data E No Data I
"	U.S.A./Puerto Rico	2,108,656 E 2,899,000 I	4,099,550 E No Data I
Qatar	Netherlands Antilles	129,000 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	1,277,478 E 4,385,000 I	2,968,539 E No Data I
Saudi Arabia	Netherland Antilles	1,286,660 E No Data I	No Data E No Data I

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN	DESTINATION	1976	1977
Saudi Arabia	Trinidad	5,559,035 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	59,410,768 E No Data I	68,688,260 E No Data I
Syria	U.S.A/Puerto Rico	No Data E No Data I	118,158 E No Data I
Trinidad	Canada	101,582 E 56,270 I	No Data E 132,534 I
"	France	No Data E 17,925 I	No Data E No Data I
"	Italy	No Data E No Data I	No Data E 26,410 I
"	Netherlands	No Data E 87,550 I	No Data E 93,987 I
"	Netherlands Antilles	59,000 E 14,945 I	No Data E 21,262 I
"	United Kingdom	No Data E 110,637 I	No Data E No Data I

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN	DESTINATION	1976	1977
Trinidad	U.S.A./Puerto Rico	7,161,516 E 6,864,358 I	7,083,574 E 7,277,529 I
"	Virgin Islands	No Data E 33,644 I	No Data E 26,410 I
United Arab Emirates	Netherlands Antilles	No Data E 2,706,000 I	No Data E No Data I
"	Trinidad	No Data E 203,000 I	No Data E No Data I
"	U.S.A./Puerto Rico	14,944,832 E 11,944,000 I	16,882,911 E No Data I
United Kingdom	Bahamas	No Data E No Data I	No Data E 214,607 I
"	Netherlands Antilles	No Data E No Data I	No Data E 826,788 I
"	U.S.A./Puerto Rico	No Data E 987,602 I	3,814,952 E 2,885,255 I
Venezuela	Belgium Luxembourg	No Data E No Data I	225,014 E No Data I

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN	DESTINATION	1976	1977
Venezuela	Brazil	No Data E No Data I	877,708 E No Data I
"	France	No Data E No Data I	833,176 E No Data I
"	Germany	No Data E No Data I	953,314 E No Data I
"	Italy	No Data E No Data I	661,729 E No Data I
"	Japan	No Data E No Data I	62,519 E No Data I
"	Netherlands	No Data E No Data I	179,683 E No Data I
"	Spain	No Data E No Data I	952,832 E No Data I
"	Sweden	No Data E No Data I	610,806 E No Data I
"	United Kingdom	No Data E No Data I	1,072,139 E No Data I

Table 4-1

ANNUAL CRUDE OIL IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN	DESTINATION	1976	1977
Venezuela	Trinidad	164,600 E No Data I	No Data E No Data I
"	U.S.A./Puerto Rico	18,401,457 E No Data I	18,240,765 E No Data I
"	Netherlands Antilles	18,618,000 E No Data I	No Data E No Data I

values are due to differences in handling shipments, transhipping and lightering operations. Figure 4-2 displays the import and exports from the Caribbean Sea area for 1977 and Figure 4-3 displays crude oil imports into the United States and Puerto Rico and exports from Mexico for the year 1977.

This data does not appear to be entirely complete but was the best computation which was available.

Annual petroleum product movements for 1976 and 1977 are included as Table 4-2 by origin and destination for countries in the wider Caribbean region. Values are reported by the exporting and importing countries and are in terms of metric tons. Discrepancies are for the same reasons as mentioned for Table 4-1.

The 1976 import and export of petroleum products for the Caribbean area is summarized in Figure 4-4.. US/Puerto Rico petroleum product trade is depicted in Figure 4-5.

Panama Canal

A major shift has occurred in the shipping of oil through the Panama Canal with the drop in Ecuadorian and Colombian crude shipments, and the transhipping of Alaskan crude oil through the canal to U.S. ports. Table 4-3 shows the source and destination by region of crude oil and petroleum products shipped through the Panama Canal for the years 1977 and 1978. Table 4-4 shows the amount of Alaskan crude oil included in the figures in Table 4-2 for the years 1977-1978 and 1979. Figure 4-6 shows the normal shipping routes taken by the tankers delivering Alaskan crude oil and other U.S. imports through the Panama Canal.

U.S. Coastal Shipment of Crude Oil and Petroleum Products

The shipment of petroleum products and crude oil between the different

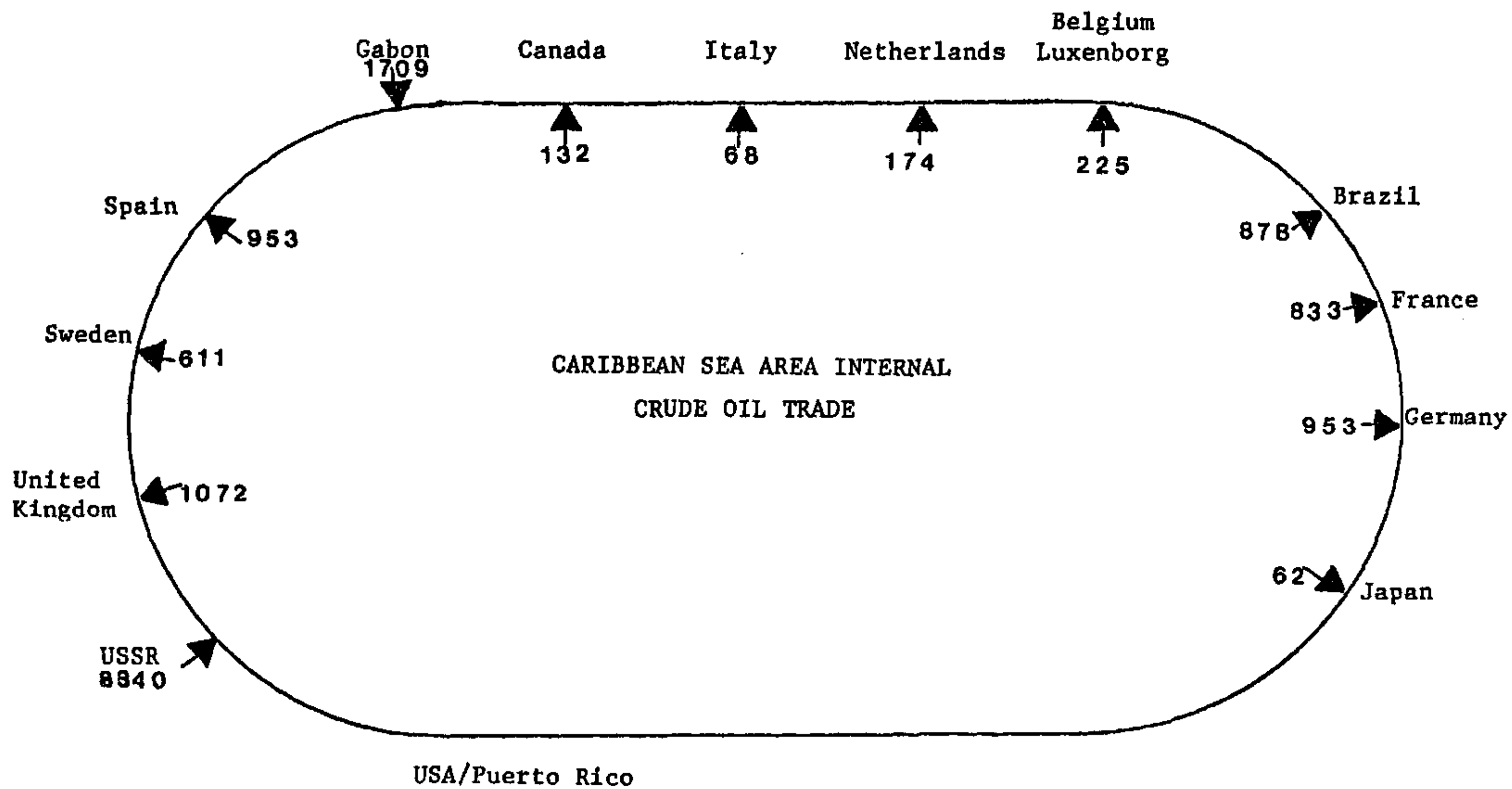


FIGURE 4-2. 1977 Crude Oil Trade in the Caribbean Region*

Each numberrepresents 1000 metric tons

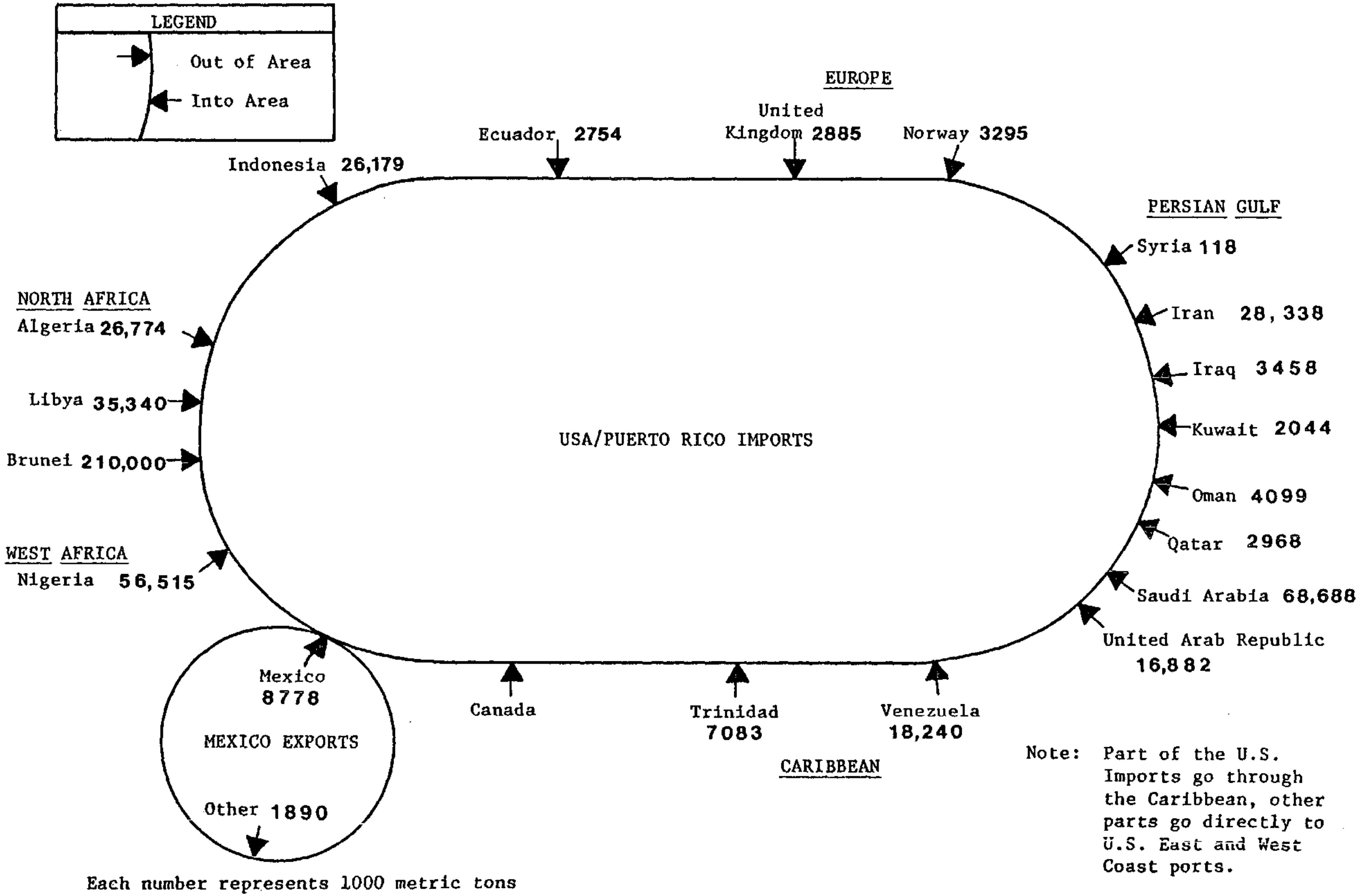


Figure 4-3. U.S. Puerto Rico Imports

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN*

I = exports to the importer reported by exporter
E = imports from the exporter reported by the importer
(all values in metric tons)

ORIGIN:	DESTINATION:	1976	1977
Bahamas	Belgium-Luxembourg	119,939 E No Data I	No Data E No Data I
"	Denmark	175,247 E No Data I	196,862 E No Data I
"	France	No Data E No Data I	24,458 E No Data I
"	Germany	385,000 E No Data I	1,155,357 E No Data I
"	Ireland	No Data E No Data I	136,543 E No Data I
"	Netherlands	221,455 E No Data I	208,901 E No Data I
"	Norway	28,333 E No Data I	32,846 E No Data I
"	Sweden	121,914 E No Data I	144,785 E No Data I

* Source: Yearbook of International Trade Statistics 1977, Volume II

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Germany	Netherland Antilles	No Data E No Data I	No Data E 40,112 I
"	Panama, Canal Zone	No Data E No Data I	No Data E 140 I
"	Puerto Rico	No Data E No Data I	No Data E 49,576 I
Italy	Bahamas	No Data E No Data I	No Data E 24,284 I
"	Netherland Antilles	No Data E No Data I	No Data E 9,281 I
"	Puerto Rico	No Data E 22,204,100 I	No Data E 2,467,097 I
Netherlands	Netherlands Antilles	3,161 E No Data I	No Data E 31,876 I
"	Puerto Rico	No Data E 443,912 I	No Data E 1,053,322 I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Bahamas	United Kingdom	131,111 E No Data I	113,596 E No Data I
Belgium-Luxembourg	Bahamas	20 E No Data I	No Data E No Data I
"	Netherlands Antilles	32 E 133 I	No Data E 77 I
"	Puerto Rico	No Data E 149,469 I	No Data E 198,966 I
Denmark	Puerto Rico	No Data E No Data I	No Data E 39,112 I
France	Netherlands Antilles	No Data E 119 I	No Data E 4,174 I
"	Panama, Canal Zone	No Data E No Data I	No Data E 54 I
"	Puerto Rico	No Data E 246,399 I	No Data E 900,897 I
Germany	Bahamas	No Data E No Data I	No Data E 1,785 I

Table 4-2
ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Netherlands Antilles	Australia	No Data E	No Data E
		60,000 I	No Data I
"	Bahamas	No Data E	No Data E
		387,000 I	No Data I
"	Belgium-Luxembourg	64,347 E	20,220 E
		54,000 I	No Data I
"	Denmark	167,616 E	22,204 E
		163,000 I	No Data I
"	France	259,258 E	55,591 E
		124,000 I	No Data I
"	Germany	498,162 E	296,953 E
		233,000 I	No Data I
"	Hong Kong	2,215 E	726 E
		1,000 I	No Data I
"	Ireland	No Data E	6,064 E
		No Data I	No Data I
"	Italy	333,499 E	42,673 E
		129,207 I	No Data I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Netherlands Antilles	Japan	No Data E 53,000 I	No Data E No Data I
"	Netherlands	507,011 E 641,000 I	83,276 E No Data I
"	Norway	73,664 E 29,000 I	No Data E No Data I
"	Panama, Canal Zone	No Data E 369,000 I	No Data E No Data I
"	Singapore	17,620 E 26,007 I	32,352 E No Data I
"	Sweden	76,443 E 26,000 I	15,896 E No Data I
"	United Kingdom	450,961 E 932,000 I	156,379 E No Data I
"	USA/Puerto Rico	No Data E 14,928,007 I	No Data E No Data I
Singapore	Netherlands Antilles	No Data E 458 I	No Data E 33,156 I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Singapore	Puerto Rico	No Data E 856,003 I	No Data E 1,469,541 I
Spain	Puerto Rico	No Data E No Data I	No Data E 859,322 I
Sweden	Puerto Rico	No Data E No Data I	No Data E 8 I
Trinidad	Bahamas	No Data E 38,540 I	No Data E 4,639 I
"	Belgium-Luxembourg	64,466 E 35,961 I	25,098 E No Data I
"	Denmark	80,607 E 40,923 I	No Data E No Data I
"	France	56,434 E 73,319 I	No Data E No Data I
"	Germany	116,555 E 35,998 I	125,394 E 497 I
"	Italy	25,249 E 10,783 I	37,892 E 21,532 I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Trinidad	Japan	No Data E 419 I	No Data E 1,396 I
"	Netherlands	135,563 E 239,596 I	231,309 E 1,223,714 I
"	Netherlands Antilles	82,000 E 128,195 I	No Data E 125,668 I
"	Norway	754 E No Data I	6,295 E No Data I
"	Panama, Canal Zone	No Data E 106,561 I	No Data E 907 I
"	Sweden	84,596 E 47,427 I	3,464 E 31,729 I
"	Switzerland	11,810 E No Data I	No Data E No Data I
"	United Kingdom	421,041 E 472,113 I	69,254 E 104,065 I
"	USA/Puerto Rico	No Data E 8,943,518 I	No Data E 7,450,027 I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
United Kingdom	Bahamas	No Data E 46 I	No Data E 116 I
"	Netherlands Antilles	2,295 E 3,538 I	No Data E 4,498 I
"	Puerto Rico	No Data E No Data I	No Data E 1,577,575 I
USA/Puerto Rico	Belgium-Luxembourg	138,753 E No Data I	122,089 E No Data I
"	Denmark	9,064 E No Data I	17,158 E No Data I
"	Finland	No Data E No Data I	2,396 E No Data I
"	France	533,990 E No Data I	947,571 E No Data I
"	Germany	1,362,436 E No Data I	1,255,655 E No Data I
"	Hong Kong	10,405 E No Data I	13,741 E No Data I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS BY ORIGIN (continued)

ORIGIN:	DESTINATION	1976	1977
USA/Puerto Rico	Indonesia	25,246 E No Data I	No Data E No Data I
"	Ireland	894 E No Data I	824 E No Data I
"	Italy	566,253 E No Data I	673,062 E No Data I
"	Netherlands	302,102 E No Data I	386,038 E No Data I
"	Netherlands Antilles	3,722 E No Data I	No Data E No Data I
"	Norway	306,799 E No Data I	288,679 E No Data I
"	Singapore	8,905 E No Data I	41,697 E No Data I
"	Sweden	63,774 E No Data I	111,775 E No Data I
"	Switzerland	4,438 E No Data I	30,915 E No Data I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
USA/Puerto Rico	United Kingdom	391,377 E No Data I	502,306 E No Data I
Venezuela	Belgium-Luxembourg	78,549 E No Data I	23,347 E No Data I
"	Denmark	150,639 E No Data I	19,482 E No Data I
"	France	176,833 E No Data I	47,558 E No Data I
"	Germany	459,304 E No Data I	3,660 E No Data I
"	Italy	1,640,501 E No Data I	888,245 E No Data I
"	Netherlands	259,398 E No Data I	18,966 E No Data I
"	Norway	134,933 E No Data I	117,068 E No Data I
"	Panama, Canal Zone	4,348,100 E No Data I	No Data E No Data I

Table 4-2

ANNUAL PETROLEUM PRODUCT IMPORTS AND EXPORTS
BY ORIGIN (continued)

ORIGIN:	DESTINATION:	1976	1977
Venezuela	Singapore	No Data E No Data I	36,057 E No Data I
"	Sweden	873,515 E No Data I	793,774 E No Data I
"	United Kingdom	671,963 E No Data I	50,598 E No Data I

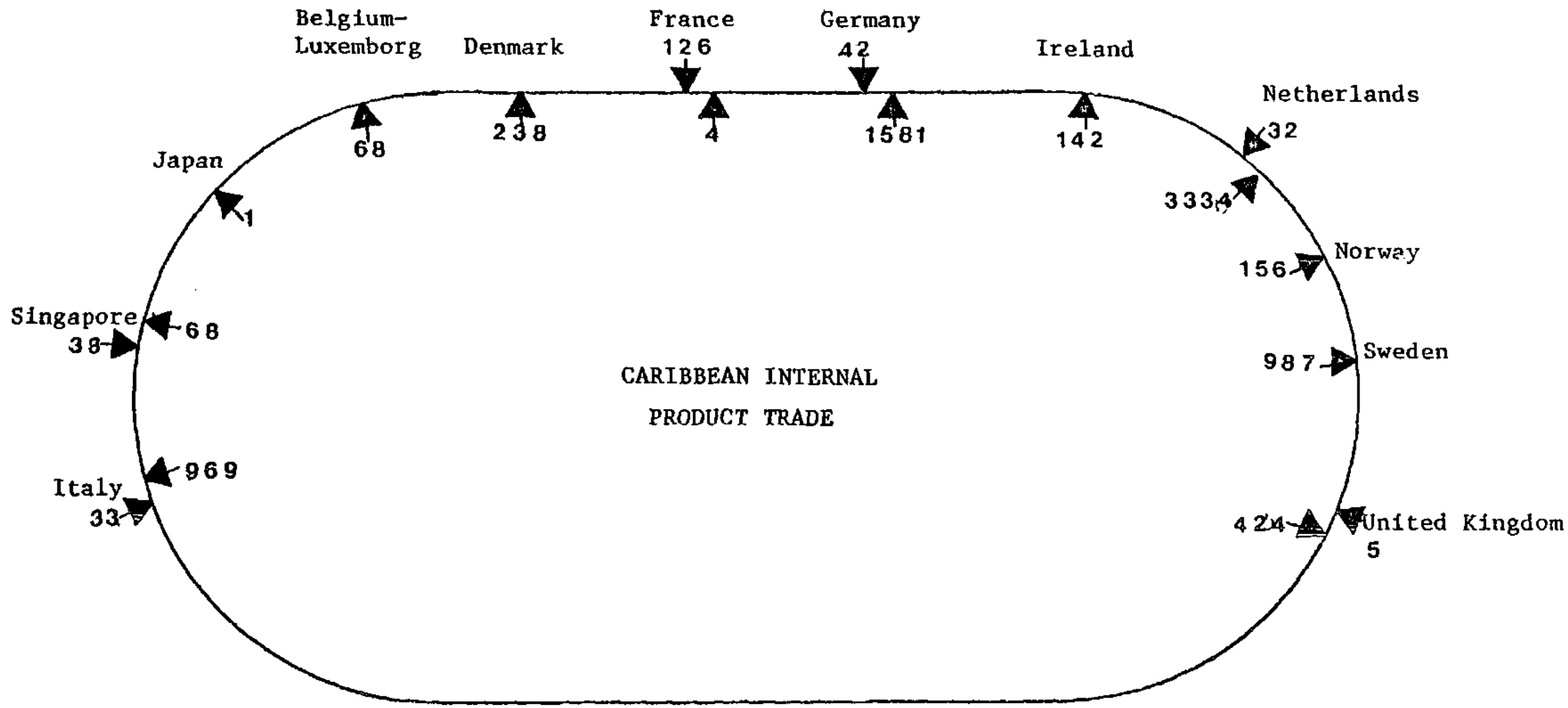
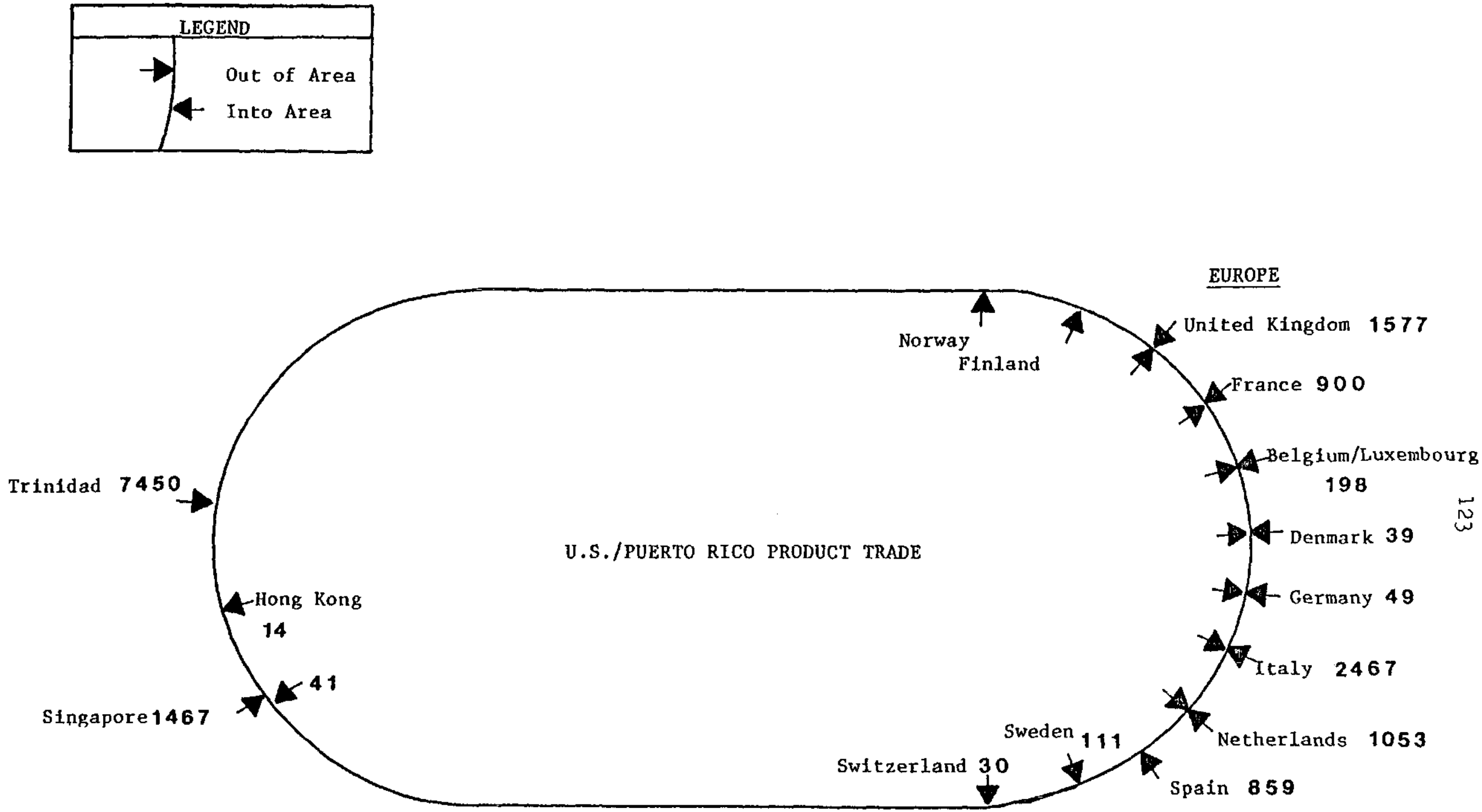


FIGURE 4-4. 1977 Petroleum Product Trade for the Caribbean Region*

*excludes USA/Puerto Rico

Each number represents 1000 metric tons



Each number represents 1000 metric tons

Figure 4-5. U.S. Puerto Rico Product Trade

Table 4-3

CRUDE OIL AND BYPRODUCT SHIPPING THROUGH THE PANAMA CANAL
FOR 1977 AND 1978 BY TRADE ROUTE*

Fiscal year: October 1 - September 30 (all values in thousands of long tons)

TRADE ROUTES		CRUDE OIL MOVEMENT		BY PRODUCT MOVEMENT+	
FROM:	TO:	1977	1978	1977	1978
Atlantic	Pacific				
East Coast Central Am.	West Coast U.S.			26	43
"	West Coast Central Am.	38	41	844	522
"	West Coast South Am.				29
"	Balboa, Canal Zone			212	203
"	Hawaii			14	
East Coast South Am.	West Coast U.S.	601	153	29	192
"	West Coast Canada	23		20	11
"	West Coast Central Am.	1979	1901	248	546
East Coast U.S.	West Coast U.S.	433	29	1021	1631
"	West Coast Central Am.			14	16
"	West Coast South Am.			53	60
"	Balboa, Canal Zone			42	65
"	Hawaii			29	
"	Oceania			42	42
"	Asia			156	172
East Coast Canada	West Coast U.S.				56
East Coast South Am.	West Coast South Am.	1864	1387	745	653
"	Balboa, Canal Zone			277	146
"	Oceania			76	1
"	Hawaii			28	78
"	Asia	410	288	30	28
West Indies	West Coast U.S.	1888	95	222	660
"	West Coast Central Am.	118	145	301	485
"	West Coast South Am.	385	10	1248	528
"	Balboa, Canal Zone			257	194
"	Hawaii			239	323

*Source: Taken from Panama Canal Company, "Important Commodity Shipments over Principal Trade Routes." See Appendix for data.

+By products include: fuel oil, gasoline, jet fuel, kerosene, diesel oil, lubricating oil, other.
By products exclude: petroleum coke

Table 4-3 (cont'd)

CRUDE OIL AND BYPRODUCT SHIPPING THROUGH THE PANAMA CANAL
FOR 1977 AND 1978 BY TRADE ROUTE

Fiscal year: October 1 - September 30 (all values in thousands of long tons)

TRADE ROUTES		CRUDE OIL MOVEMENT		BY PRODUCT MOVEMENT	
FROM:	TO:	1977	1978	1977	1978
West Indies	Oceania			242	231
"	Asia			120	54
Europe	West Coast U.S.			14	59
"	West Coast Central Am.			28	
"	West Coast South Am.			3	5
"	Oceania			12	8
"	Asia			20	9
Africa	West Coast U.S.	41		35	
	TOTAL	7780	4049	6718	7050
Pacific	Atlantic				
West Coast U.S.	East Coast U.S.	432	15,751	1041	1606
"	East Coast South Am.			3	25
"	Cristobal, Canal Zone				213
"	West Indies		1190		105
"	Europe			185	252
"	Africa			18	16
"	Asia (Middle East)				18
West Coast Canada	East Coast U.S.			29	
West Coast South Am.	East Coast U.S.	751	3090	280	797
"	East Coast Canada				19
"	East Coast Central Am.	1348	1573	4	
"	East Coast South Am.	1701	1570	15	24
"	West Indies	470	997	21	122
"	Europe		54	21	
"	Africa			20	
Oceania	East Coast U.S.			146	90
Asia	East Coast U.S.			36	36
"	West Indies			79	3
"	Europe			5	4
	TOTAL	4702	24,225	1903	3330

Table 4-4

CRUDE OIL SHIPMENTS THROUGH PANAMA CANAL*
(in thousands long tons) 1/

	77 2/	78	79 3/	Projected	Metric Tons
North Slope (Alaska)	432	16,182	10,472	(16,060)	16,352
Other	15,165	12,092	8,163	(12,518)	8,311
Total (1000 long tons)	15,597	28,274	18,635	(28,578)	29,097
(1000 bbl/day)	299	542	530		

1/ 7 bbl/long ton, short ton - 2000 lbs.
long ton - 2240 lbs.
metric ton - 2200 lbs.

2/ North slope shipments began late August 1977.

3/ October - April (238 days)

(Projected based on 365 days at current rate)

* Source: EPS, Panama Canal Company

regions of the United States is shown in Table 4-5. It may be noted that approximately 67 million metric tons or 470 million barrels were shipped from U.S./ Gulf of Mexico ports and another 4 million metric tons was shipped to U.S./ Gulf of Mexico ports.

Venezuela

The destination of crude oil and products shipped from Venezuela are shown in Table 4-6. This data parallels that presented in Figure 4-1 and 4-2, but is repeated since it is direct data from Venezuela. Table 4-7 shows port of origin for Venezuela exports.

Figure 4-7 shows the main shipping lanes for the transport of Venezuelan and Trinidad and Tobago crude oil and refined products.

North African, West African and Middle East Crude Oil Transport Routes

Verbal reports indicate that about 700,000 bbl/day enter the Caribbean from the Middle East, 600,000 bbl/day enter the Caribbean from West Africa (primarily Nigeria) and 200,000 bbl/day from North Africa. Of this, 1,500,000 bbl/day approximately 1,000,000 bbl/day is lightered in the Gulf of Mexico for entry into U.S. Gulf of Mexico ports. (Figure 4-8).

Total Caribbean Crude Oil Throughput

Information provided by the membership of the Clean Caribbean Cooperative indicated that their companies ship approximately 2,800,000 barrels per year of crude oil to or through the Caribbean. The addition of the 530,000 barrels per day of crude oil shipped through the Panama Canal and an estimated 1,370,000 barrels per day from other areas by non-member companies brings the total to

Table 4-5

TANKER VESSEL COMMERCE OF THE U.S. BY
PRINCIPLE TRADE ROUTES THROUGH THE WIDER
CARIBBEAN. CALENDAR YEAR 1977+

FROM:	TO:	Self-propelled* Tank Vessel (1000 short tons)	(metric tons)	Non self-propelled** Tank Vessel (1000 short tons)	(metric tons)
East Coast United States (N. & S. Atlantic)	U.S. Gulf of Mexico	2,131,794	1,938,013	191,057	173,689
	West Coast U.S.	90,972	82,702		
	Puerto Rico/Virgin Islands	18,263	16,602	74,223	67,476
	TOTAL	2,241,029	2,037,317	265,280	241,165
U.S. Gulf of Mexico	U.S. Gulf of Mexico	12,245,256	11,132,162	6,309,169	5,735,666
	East Coast U.S.	59,504,580	54,095,614	6,649,982	6,045,499
	Puerto Rico/Virgin Islands	413,592	375,996	62,588	56,899
	West Coast U.S.	1,400,548	1,273,238		
	TOTAL	73,563,976	66,877,010	13,021,739	11,838,064
Puerto Rico/Virgin Islands	U.S. Gulf of Mexico	1,958,213	1,780,211	252,181	229,258
	East Coast U.S.	24,927,461	22,661,555	1,101,706	1,001,561
	Puerto Rico/Virgin Islands	170,023	154,568	3,094,621	2,813,320
	West Coast U.S.	145,847	132,589		
	TOTAL		24,728,923		4,044,139
West Coast U.S. (Alaska, California Pacific N.W.)	Gulf	456,519	415,021		
	East Coast	667,245	606,592		
	TOTAL	1,123,764	1,021,613		

*includes commodities such as gasoline, fuel oil, crude petroleum, jet fuel, lub oil. Crude oil accounts for 16% of the commodities shipped by self-propelled tank vessel.

**includes commodities such as gasoline, fuel oil, asphalt, jet fuel, petroleum crude oil products.

+Source: Domestic U.S. Waterborne Trade.

Table 4-6

VENEZUELA CRUDE AND BYPRODUCT EXPORT BY DESTINATION
1976-1977
(BBL)

	1 9 7 6			1 9 7 7*		
COUNTRY	CRUDE	PRODUCT	TOTAL	CRUDE	PRODUCT	TOTAL
UNITED STATES	82.329.700	170.101.221	252.430.921	110.196.706	153.983.471	264.180.177
ARUBA	101.889.972	23.022.823	124.912.795	96.939.110	10.320.761	107.259.871
CANADA	95.905.080	6.874.255	102.779.335	82.636.313	10.070.334	92.706.247
CURACAO	69.810.547	1.380.767	71.191.314	50.644.968	7.067.847	57.712.815
PUERTO RICO	34.382.448	11.636.029	46.018.477	32.131.422	14.365.542	46.496.964
JAMAICA	9.055.344	1.686.454	10.741.798	6.371.332	1.728.171	8.099.503
DOMINICAN REPUBLIC	9.374.444	397.980	9.772 424	8.654.138	545.188	9.199.326
PANAMA	5.170.773	2.926.846	8.097.619	5.241.800	2.687.011	7.928.811
BRAZIL	5.274.633	2.480.422	7.755.055	5.937.506	3.562.280	9.499.786
DELIVERED TO SHIPS	-	7.534.413	7.534.413	-	7.839.459	7.839.459
EUROPE	36.658.077	27.288.850	63.946.927	24.213.918	13.864.881	38.078.799
OTHER COUNTRIES	51.676.705	30.940.955	82.617.660	62.448.525	25.452.757	87.941.282
TOTAL EXPORTS	501.527.723	286.271.015	787.798.738	485.455.733	251.487.702	736.943.440

*ESTIMATE

Source: List of Exported Sales. Minister of Energy and Mines.

Table 4-7

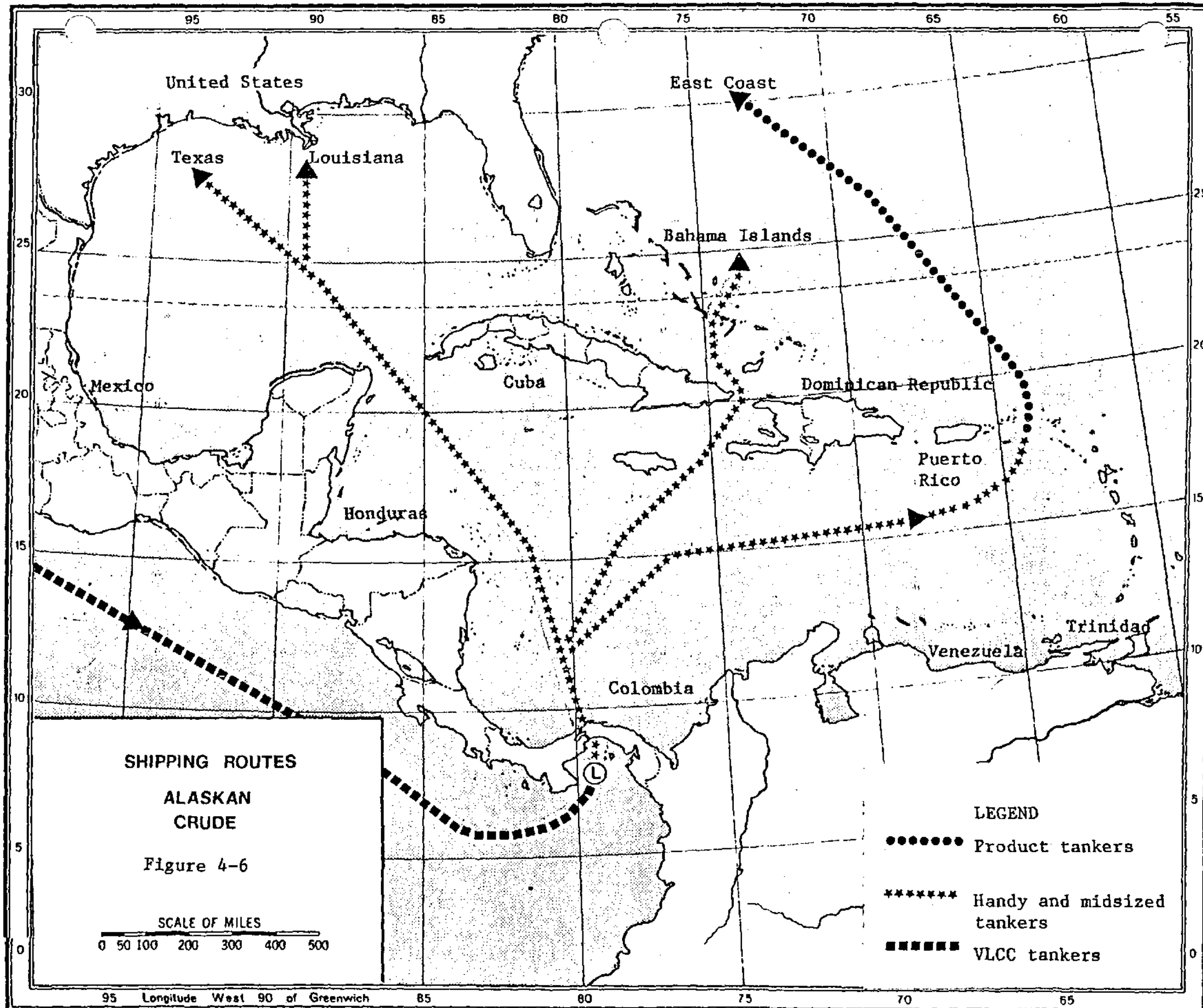
1977 CRUDE OIL AND PETROLEUM PRODUCTS
EXPORTS FOR VENEZUELAN PORTS*

(all values in cubic meters+)

TERMINAL:	TOTAL CRUDE OIL	TOTAL BY PRODUCTS
Amuay	6,108,291	16,358,031
Bajo Grande	2,554,748	961,840
Cardon	8,187,799	9,131,866
Caripito	3,181,475	153
El Chaure	-	1,127,044
Guaraguao	11,192,624	-
El Palito	81,838	3,140,217
La Estacada	1,593,362	-
La Salina	22,390,153	80,731
Moron	-	402,624
Pamatacual	-	96,043
Puerto La Cruz	-	3,602,099
Puerto Miranda	16,749,740	117,570
Puerto Ordaz	2,446,403	91,965
Punta de Palmas	2,156,802	-
Tucupita	-	93,894
Uracoa	638	-
TOTAL	76,643,873	35,204,077

* Source: Department of the Treasury

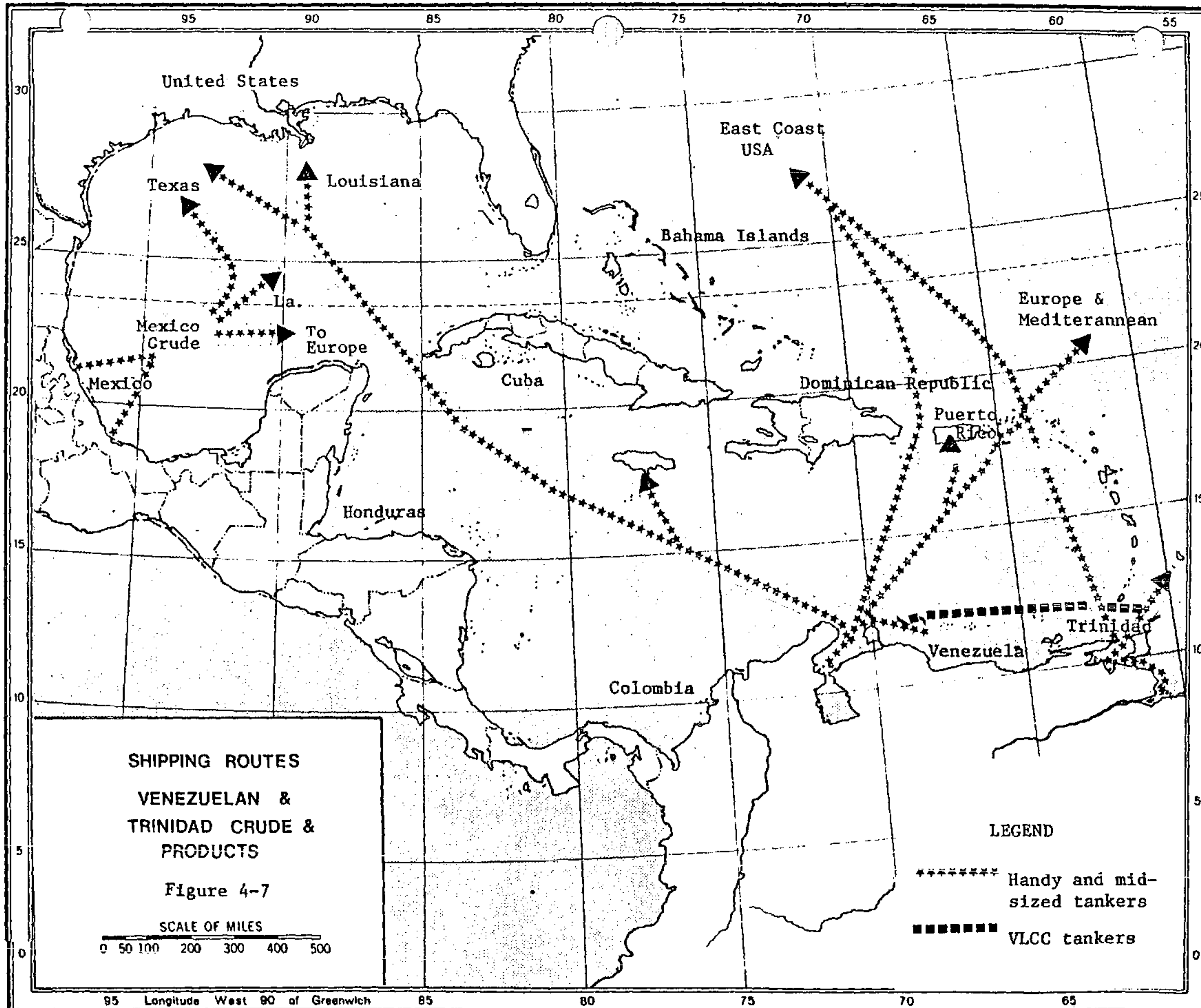
\+ 1 cubic meter = 6.3 barrels (42 US gallons)



SHIPPING ROUTES

ALASKAN CRUDE

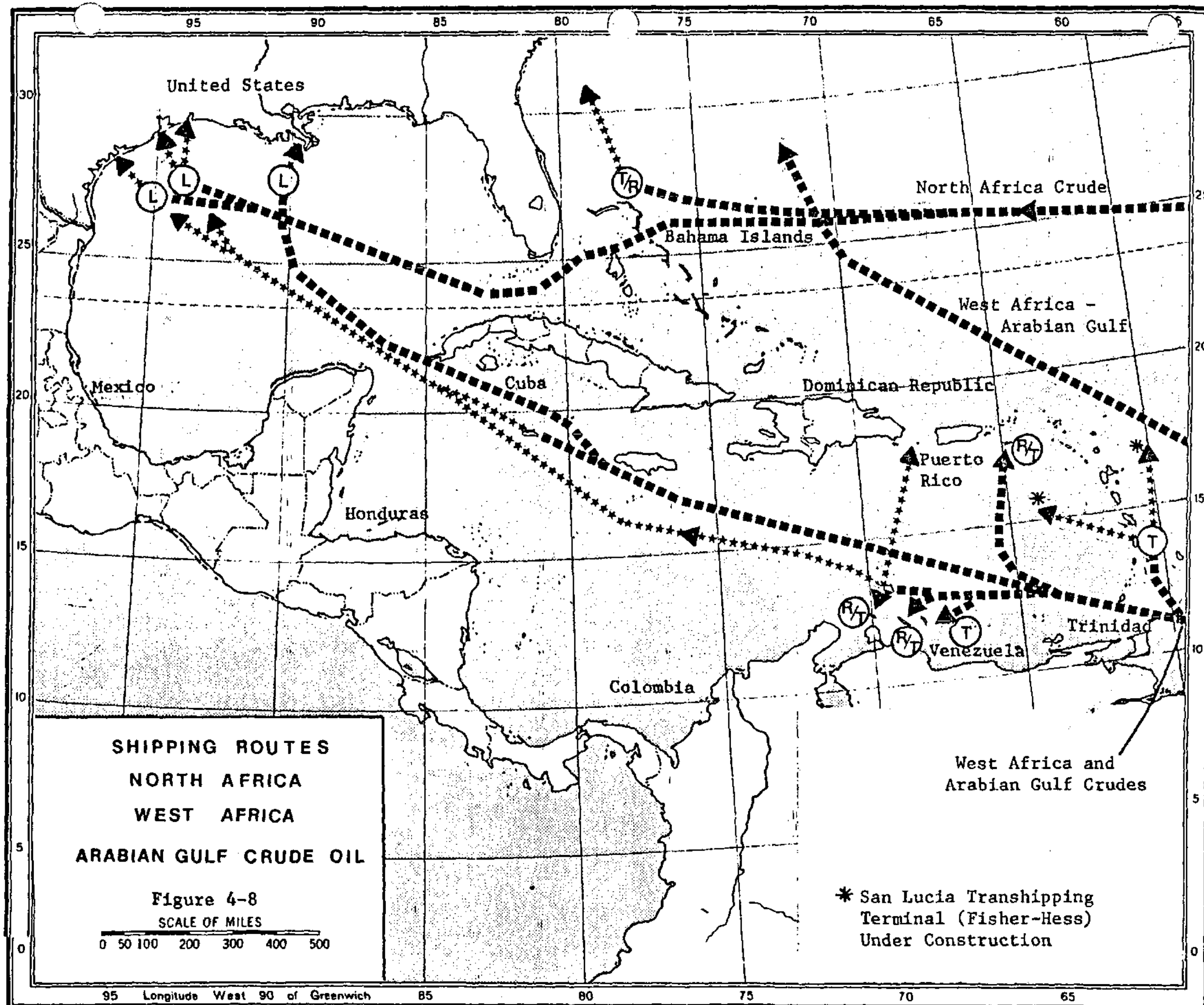
Figure 4-6



SHIPPING ROUTES

VENEZUELAN & TRINIDAD CRUDE & PRODUCTS

Figure 4-7



SHIPPING ROUTES
NORTH AFRICA
WEST AFRICA
ARABIAN GULF CRUDE OIL

Figure 4-8

4,700,000 barrels per day or 1,743 million barrels/year assuming 7 bbl per metric ton this would equal approximately 250,000,000 tons per year. (Table 4-8)

These figures count each oil shipment only once. For example oil shipped to a transshipping terminal and then reshipped to its final destination is considered to be one overall shipment through the area.

At the present time it has been reported that approximately half of this oil is transported in VLCC's (supertankers) averaging 200,000 tons and the other half in mid-sized and handy-sized ship averaged 60,000 tons. Thus there would be 625 supertanker passages per year through the Caribbean and 2083 mid-sized voyages per year. This would average 2 supertankers and 6 mid-sized tankers entering and leaving the Caribbean each day. Assuming each tanker traversed 2500 nautical miles of Wider Caribbean waters at an average of 200 kts per day, the average time in the Wider Caribbean would be 12.5 days for a one-way voyage.

Thus at any one time it would be expected that there would be approximately 25 loaded VLCC's and 25 returning VSCC's in the Wider Caribbean and 75 loaded mid- and handy-sized tankers and 75 returning mid- and handy-sized tankers in the Wider Caribbean at any one time. To this would be added any tankers to or from Mexico or coastal tankers in the United States or Mexico. It also does not take into account the extra numbers of smaller tankers utilized in transshipping and lightering service.

Tanker Ports in the Wider Caribbean Region

There are over 50 tanker ports in the Wider Caribbean. They range in capacity to handle 10,000 to 530,000 deadweight tons (DWT) maximum vessel size. Ports located along the Texas coast are shown in Figure 4-9. Estimated channel depth and maximum DWT capacity are included for each port listed. Table 4-9

Table 4-8

ESTIMATED 1978 OIL SHIPMENTS
TO AND THROUGH CARIBBEAN

	Million bbl/day	Million bbl/yr
Clean Caribbean Companies Trinidad & Tobago		
Amoco	3.6	1,341
Bahamas Oil		
Bonaire		
Burmah		
Esso		
Mobil		
Shell		
Sun		
Texaco		
Other		
Sohio (approximately)	.2	73
Hess (approximately)	.4	146
Marathon		
Ashland		
Coastal States		
Phillips	.5	183
U.S. DOE		
Other misc.		
TOTAL	4.7	1,743

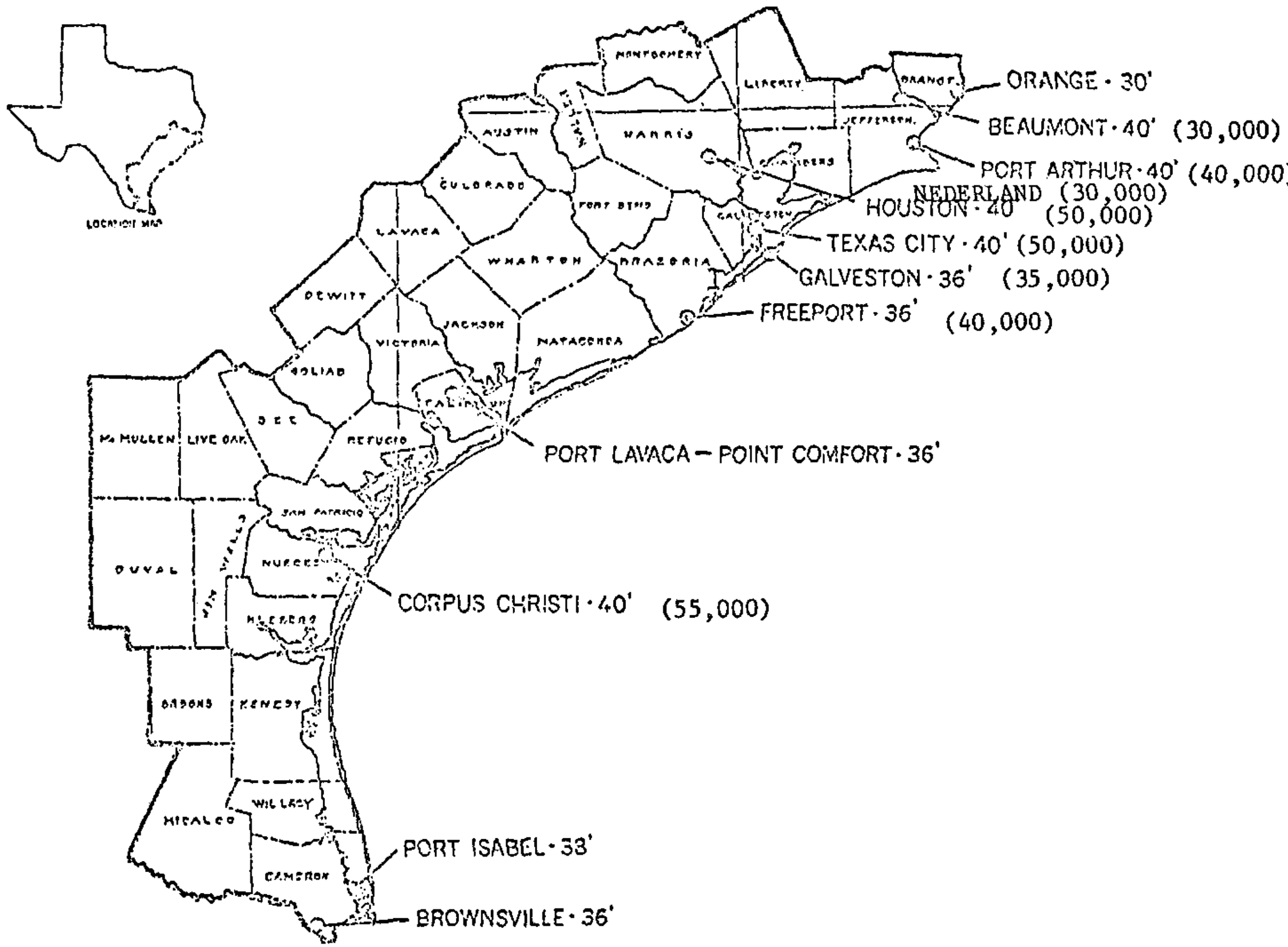


Figure 4-9. Existing Channel Depths of Texas Ports Including Estimated Maximum Vessel Size (Loaded) in Dead Weight Tons (DWT)

Table 4-9

TANKER PORTS IN THE WIDER CARIBBEAN REGION*

Port	Estimated Maximum Vessel Size In DWT Current
U.S.A.	
Baton Rouge, LA	50,000
Baytown, TX	50,000
Beaumont, TX	30,000
Corpus Christi, TX	55,000
Freeport, TX	40,000
Galveston, TX	35,000
Houston, TX	50,000
Lake Charles, LA	40,000
Mobile, ALA	50,000
Nederland, TX	30,000
New Orleans, LA	50,000
Pascagoula, MISS	50,000
Port Arthur, TX	40,000
Tampa, FLA	unknown
Texas City, TX	50,000
MEXICO	
Veracruz	
Tuxpan	
Tampico	
Salina Cruz	
Coalzacoalas	
BAHAMAS	
Freeport	380,000
South Riding Point	440,000
BARBADOS	
Bridgetown	36,000
COLOMBIA	
Cartagena	40,000
CUBA	
Havana	40,000
Santiago de Cuba	35,000
DOMINICAN REPUBLIC	
Palenque	110,000
Santa Domingo	10,000 160,000**

Port	Estimated Maximum Vessel Size In DWT Current
GUATEMALA	
San Jose	35,000
HONDURAS	
Puerto Cortes	75,000
JAMAICA	
Kingston	30,000
MARTINIQUE	
Fort de France	20,000
NETHERLANDS ANTILLES	
Aruba	500,000
Bonaire	500,000
Curacao	530,000
PANAMA	
Puerto Las Minas	40,000
PUERTO RICO	
Guayanitta	40,000
Los Mareas	40,000
Port Yacuboa	100,000
San Juan	25,000
TRINIDAD	
Brighton	20,000
Galeota Point	250,000
Point Fortin	80,000
Point-a-Pierre	260,000
VENEZUELA	
Amuay Bay	70,000
Bajo Grande	55,000
Carapito	48,000
Cumerebo	40,000
Puerto la Cruz	110,000
Puerto Miranda	90,000
Punta Cardon	47,000
Punta Cuchillo	47,000
VIRGIN ISLES	
St. Croix	170,000

*Source: 1978 IPE
**Single Point Mooring System

lists other U.S./Gulf Coast ports and those of South America and in the Caribbean area. Table 4-10 lists by country and location the single point mooring installations for the region. Maximum tanker size is also included with the number and size of hose system. Major Caribbean ports are shown in Figure 4-10. This figure indicates all major ports excluding those in Venezuela. Venezuelan ports are shown in Figure 4-11.

Oil Pollution Resulting from Transportation

In 1969 and 1970 the average annual amount of oil pollution in the oceans from all sources was almost 5 million metric tons. At that time, 46 percent of the oil originated due to vessels, barge and vessel related operations. The oil discharge from tankers and tanker-related operations is as a result of casualties and loading and unloading accidents and operational discharges such as tank washing, oily ballast, and bilge water.

Tanker Related Accidental Spills

Table 4-11 lists transportation related spills in the Wider Caribbean for the year 1978. These serve to indicate that major spills are occurring in this area. The Aegean Captain-Atlantic Empress collision off Tobago in July of 1979 where 500,000 tons of crude oil cargo was at risk and partially spilled indicates the potential magnitude of the problem in the Wider Caribbean area.

Tables 4-12, 4-13 and 4-14 present information on tanker accident analysis for the period 1969-1972. This work examines accidents by type and location and by size of ship. It also provides a method of calculating expected spill volumes and frequency based on number of port calls, volume of cargo and number of vessel years.

These statistics have been used with Wider Caribbean Oil Throughput and number of port calls to predict potential levels of spills.

Table 4-10

SINGLE POINT MOORING INSTALLATIONS IN
THE WIDER CARIBBEAN REGION*

Year Installed	Country	Location	Owner	Tanker Size	Hose System No., Size
1972	Dominican Republic	Santa Domingo	Shell	150,000	2x16 in + 1x12 in
1973	Mexico	Tuxpan	Pemex	60,000	2x16 in
1974	"	"	"	"	3x16 in + 1x10 in
1975	"	Salina Cruz	"	"	3x16 in + 1x10 in

*Source: 1975 IPE

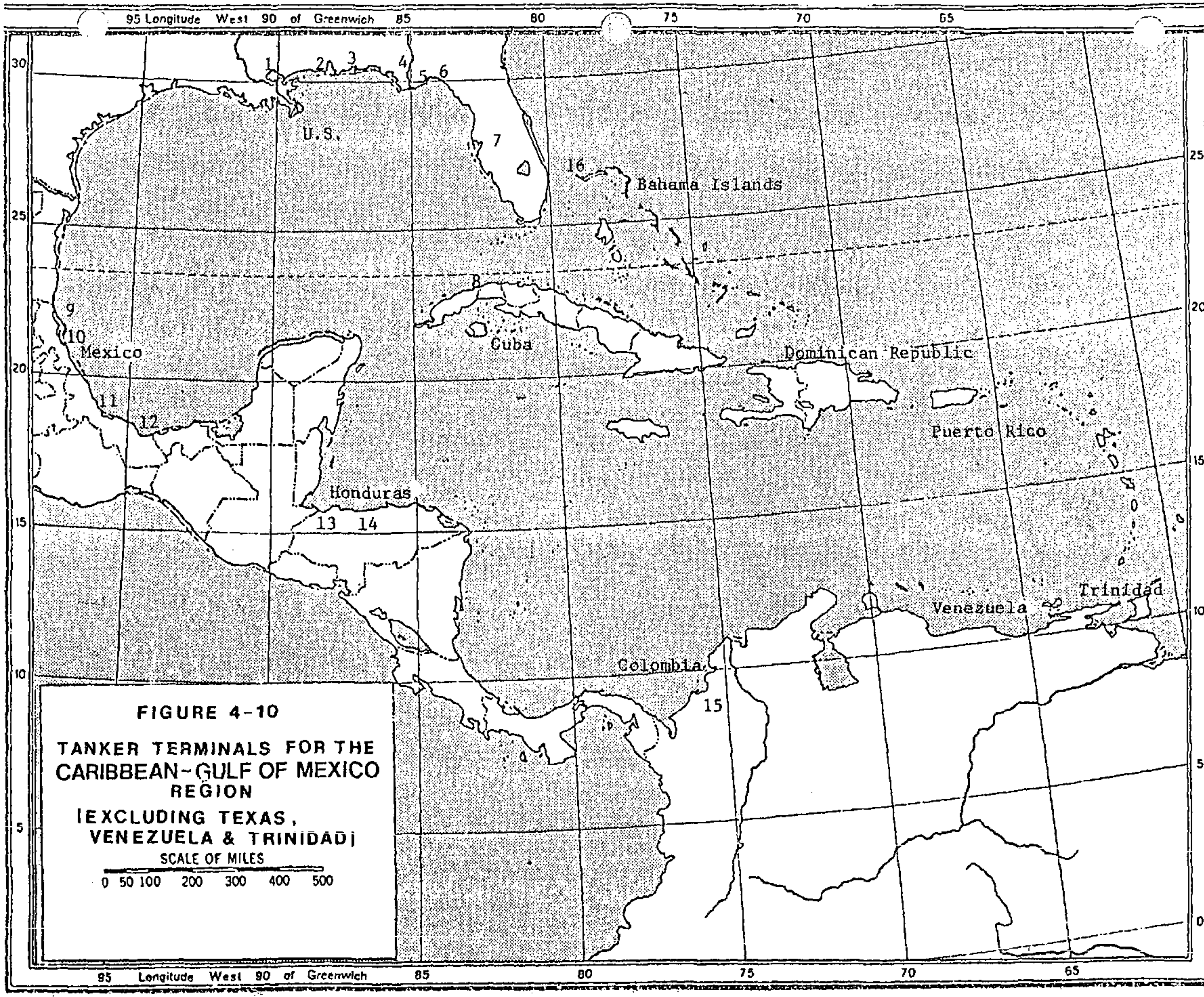
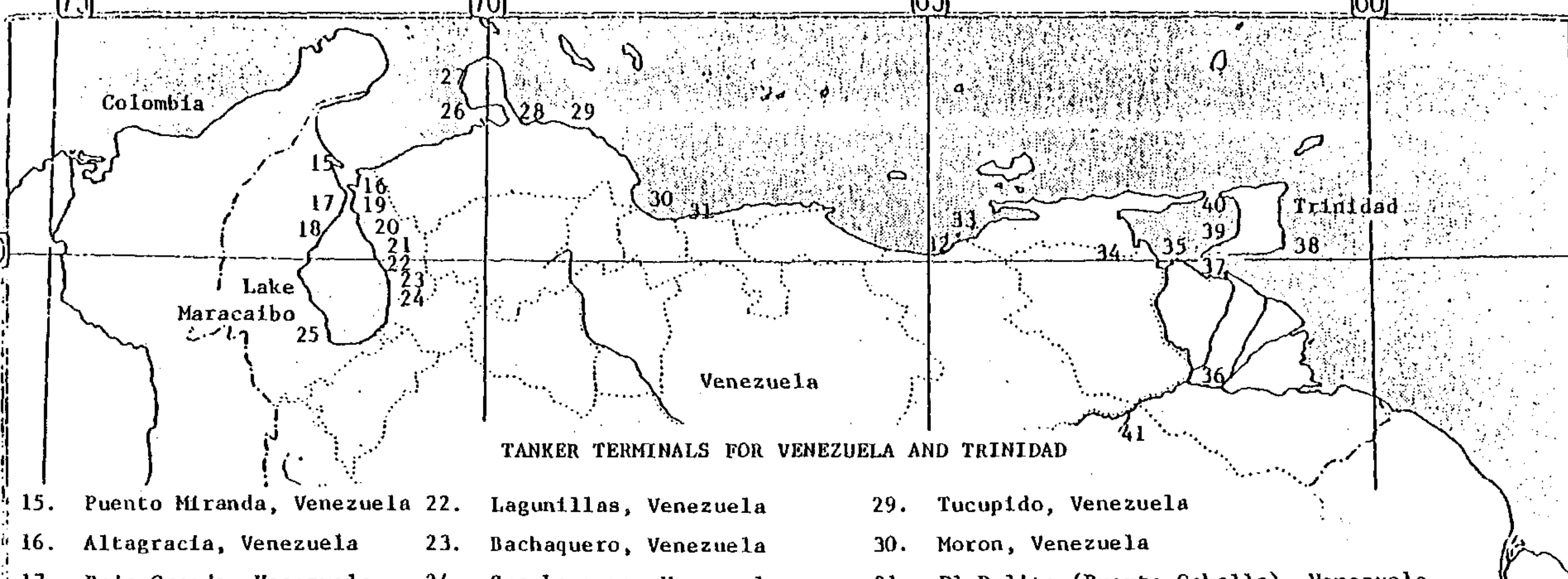


FIGURE 4-10

TANKER TERMINALS FOR THE CARIBBEAN-GULF OF MEXICO REGION (EXCLUDING TEXAS, VENEZUELA & TRINIDAD)

TANKER TERMINALS FOR THE CARIBBEAN-GULF OF MEXICO REGION
(Excluding Texas, Venezuela and Trinidad)

1. New Orleans, Louisiana
2. Pascagoula, Louisiana
3. Pensacola, Florida
4. Panama City, Florida
5. Port St. Joe, Florida
6. St. Marks, Florida
7. Tampa, Florida
8. Havana, Cuba
9. Tampico, Mexico
10. Tuxpan, Mexico
11. Veracruz, Mexico
12. Coalzacoalcos, Mexico
13. Puerto Cortes, Honduras
14. Tela, Honduras
15. Covenas, Colombia
16. Freeport, Bahama



TANKER TERMINALS FOR VENEZUELA AND TRINIDAD

15. Puento Miranda, Venezuela
16. Altagracia, Venezuela
17. Bajo Grande, Venezuela
18. Puento de Palmas
19. Ule, Venezuela
20. La Salina, Venezuela
21. Tia Juana, Venezuela
22. Lagunillas, Venezuela
23. Bachaquero, Venezuela
24. San Lorenzo, Venezuela
25. Boca Escalente, Venezuela
26. El Cardon, Venezuela
27. Amuay Las Piedras, Venezuela
28. Puerto Cumarebo, Venezuela
29. Tucupido, Venezuela
30. Moron, Venezuela
31. El Palito (Puerto Caballo), Venezuela
32. Puerto La Cruz, Venezuela
33. Guanta, Venezuela
34. Carpito, Venezuela
35. Capure
36. Tucupita
37. Point Fortin, Trinidad
38. Galeota Point Trinidad
39. Brighton, Trinidad
40. Point a Pierre, Trinidad
41. San Felix, Venezuela

TANKER TERMINALS FOR VENEZUELA AND TRINIDAD

FIGURE 4 -11

Kilómetres

0 400

5 5 65 60

Table 4-11

WIDER CARIBBEAN AREA
SUMMARY OF 1978 REPORTED OIL SPILLS
RELATED TO OIL TRANSPORTATION

Date	Source	Location	Gallons spilled	Type oil	Cause
23 Jan	Bayou Willow barge	29°30' N, 94°52' W Galveston Bay, Texas	50,000	No. 6 fuel	collision
31 Jan	Domar 6501 barge	(29°17' N, 91°50' W) (Point au Fer, Louisiana)	252,000	No. 6 fuel	collision
10 Feb	barge	29°45' N, 95°05' W Texas	38,000	jet fuel	grounding
11 Feb	STC-2002 barge	29°45' N, 95°25' W Houston, Texas	20,000	jet fuel	grounding
30 Mar	Mary barge	(30°00' N, 90°03' W) (New Orleans, Louisiana)	42,000	No. 6 fuel	ramming
4 May	barge	Mile 6, Intracoastal Waterway, Louisiana	21,000	gasoline	collision
26 May	oil transfer dock Amerada Hess Corp.	(30°41' N, 88°05' W) (Mobile, Alabama)	85,000	No. 2, No. 6, crude	• ramming • hose rupture
19 Jun	unknown	30°13' N, 81°23' W Mayport, Florida	62,000	marine diesel fuel	unknown
21 Aug	Theopaes (GR - 34,139 DWT) Frotanorte bulk carrier (BRA-25,035 DWT)	16°48' N, 69°00' W (off San Juan, Puerto Rico)	(up to 60,000) (122,000)	• undetermined • undetermined	collision
5 Oct	Howard Star - alleged bulk carrier (PA - 52,280 DWT)	(27°58' N, 82°38' W) (Tampa, Florida)	(up to 40,000)	diesel & bunker C	ballasting
31 Oct	unknown	(10°50' N, 61°40' W) NW Trinidad	5-sq-km-slick	undetermined	intentional discharge
19 Dec	Peck Slip barge	(18°29' N, 66°08' W) (Cape San Juan, Puerto Rico)	462,000	bunker C	grounding

Source:

OIL SPILL INTELLIGENCE REPORT / 23 MARCH

TABLE 4-12

LOCATIONS AND CAUSES OF WORLD WIDE TANKER CASUALTY SPILLS, 1969-1972*

	Breakdowns	Collisions	Explosions	Fires	Groundings	Rammings	Structural Failures	Others	Total
Spills in Coastal Waters (< 50 Miles From Land):									
Number	10	171	32	48	171	43	36	11	522
Bbl Spilled	457	1,394,347	285,630	43,402	1,379,580	64,095	383,925	167,213	3,718,649
Avg. Size, Bbl	46	8,154	8,926	904	8,068	1,491	10,665	15,201	7,124
Spills at Sea (> 50 Miles From Land):									
Number	8	8	14	5	0	2	79	4	120
Bbl Spilled	122,678	3,518	409,695	1,523	0	1,020	2,010,368	255,855	2,804,657
Avg. Size, Bbl	15,335	440	29,264	305	-	510	25,448	63,964	23,372
All Spills									
Number	18	179	46	53	171	45	115	15	642
Bbl Spilled	123,135	1,397,865	695,325	44,925	1,379,580	65,115	2,394,293	423,068	6,523,306
Avg. Size, Bbl	6,841	7,809	15,116	848	8,068	1,447	20,820	28,205	10,161

TABLE 4-13

WORLD WIDE TANKER CASUALTY SPILLS VS. VESSEL SIZE 1969-1972*

Vessel Size (DWT)	Average Number of Vessels	Number of Spills	Spills Per Vessel Per Year	Volume Spilled (Bbl)	Bbl Spilled Per Vessel Per Year	Average Spill Size (Bbl)
<10,000	2,885	148	0.013	159,435	13.5	1,058
10,000 - 19,999	1,119	155	0.035	1,715,040	383.3	11,078
20,000 - 29,999	638	104	0.041	760,170	297.8	7,298
30,000 - 39,999	450	68	0.038	1,462,583	812.3	21,488
40,000 - 49,999	298	37	0.031	768,075	644.3	20,783
50,000 - 59,999	209	26	0.031	199,058	237.8	7,643
60,000 - 69,999	153	21	0.034	71,145	116.3	3,390
70,000 - 79,999	150	15	0.025	108,255	180.8	7,230
80,000 - 89,999	95	17	0.045	59,055	155.3	3,473
90,000 - 99,999	91	8	0.022	97,665	268.5	12,203
100,000 - 149,999	128	14	0.028	1,004,700	1,960.5	71,813
150,000 - 199,999	35	3	0.021	1,223	9.0	420
≥200,000	121	26	0.054	116,903	241.5	4,455
All Vessels	6,368	642	0.025	6,523,305	255.8	10,148

*Source: Beyer, A.H. and L.J. Painter, 1977 Oil Spill Conference, (27)

TABLE 4-14

HISTORICAL PARAMETERS FOR PREDICTING TANKER CASUALTY SPILLS WITHIN 50 MILES OF LAND*

Exposure Variable	Spill Frequency		Spill Size		Generally Suitable For Use When:
	Mean	Basis	Mean (Bbl)	Basis	
Number of Port-Calls	0.92 spills/10^3 port-calls	1969-1970 worldwide spills < 50 miles from land and 1969-1972 spills at 7 major U.S. ports [6,7,14,17]	7,100	1969-1972 worldwide spills < 50 miles from land [6,7]	The tanker fleet, total volume of cargo, and trade routes are known.
Volume of Cargo Transported	12 spills/10^9 bbl transported	1969-1972 worldwide spills < 50 miles from land [6,7,17]	7,100	Same as above	The total volume of cargo is known, but the tanker fleet and trade routes are uncertain.
Number of Vessel-Years	20 spills/10^3 vessel-years	1969-1972 worldwide spills < 50 miles from land [6,7,17]	7,100	Same as above	The tanker fleet is known, but the total volume of cargo and trade routes are uncertain.

* Source: Beyer, A.H. and L.J. Painter, 1977 Oil Spill Conference (27)

This analysis for both accidents within 50 miles of shore and outside within 50 miles from shore based on volume of cargo transported is presented as Part A of Table 4-15.

This analysis indicates a likelihood of 21 spills per year averaging 1000 metric tons within 50 miles of land and 4.8 spills averaging 3338 metric tons outside of 50 miles from land.

The analysis based on number of port calls is shown in Part B of Table 4-15. This analysis indicates 12.3 spills per year with an average volume of 1000 metric tons within 50 miles of land.

The reader may want to adjust these figures to reflect such intangibles as improved performance since 1969-72, quality of ships and crews used in the Wider Caribbean and expected safety records in transshipping and lightering.

Operational Discharges

The variety of operational discharges experienced from tanker and chemical product tankers is demonstrated by the data from the Houston Ship Channel area shown as Table 4-16. Each of these discharges is significant in the local Caribbean ports which experience these discharges either to the environment or to local treatment facilities.

Of even greater importance to the Caribbean area are the discharges of tank washings into the Atlantic as well as the Caribbean. These discharges amount to the greatest tanker related dose of oil pollution to the marine environment and are believed responsible for the tar spots and tar balls which often appear on Caribbean and Gulf of Mexico beaches.

Tankers have been .35 and .5 percent of their cargo settle out during long sea voyages. Earlier practice and that still followed by unscrupulous operators was to discharge this residue to the sea with tank wash water. This discharge

Table 4-15

POTENTIAL TANKER RELATED SPILLS
WITHIN FIFTY MILES OF LAND

A. Based on Volume of Cargo Transported

Volume 1.743×10^9 bbl/yr

Spill Rate Experience 12 spills/10^9 bbl

< 50 miles from land
> 50 miles from land 2.76 spills/10^9 bbl

and

Expected Rate $1.743 \times 12 - 21.3$ spills/yr

$1.743 \times 2.76 = 4.8$

Average size of spill = 7100 bbl or 1000 metric tons

< 50 miles from land

Average size of 4.8 spills = 23,372 bbl or 3,338 metric tons

> 50 miles from land

B. Based on Number of Port Calls

Supertanker Voyages	=	1250 unloadings
MBWT & Handy	=	2083 loadings
Lighter & Tranship	=	10000 loadings and unloadings
(Assume 40,000 ton avg i.e. supertanker x 5)		
		13333 port calls/year

Rate of spills = .92 per 10^3 port calls

Expected rate = $.92 \times 8.333 = 12.27$ spills/year

Average size of 12.27 spill = 7100 bbl or 1000 metric tons

< 50 miles from land

Table 4-16

SUMMARY OF VESSEL WASTE DISTRIBUTION FOR
THE HOUSTON SHIP CHANNEL, TEXAS CITY AND GALVESTON WHARVES

Waste Type	Houston Ship Channel: Turning Basin	Houston Ship Channel: Turn. Basin to San Jac. River	Houston Ship Channel: San Jac. River to Morgans Pt.	Texas City	Galveston Wharves	Total	Remarks
Ballast	880,000 Gal/Mo	44,025,000 Gal/Mo	43,145,000 Gal/Mo	1,950,000 Gal/Mo	-0-	90,000,000 Gal/Mo	Contains oil residue, discharged into water.
Ship Cleaning (Interior)	50,000 Gal/Mo	18,000 Gal/Mo	465,000 Gal/Mo	-0-	-0-	533,000 Gal/Mo	Treated in dockside facilities.
Ship Cleaning (Exterior)	18,000 Gal/Mo	7,000 Gal/Mo	-0-	-0-	5,000 Gal/Mo	30,000 Gal/Mo	Discharged into water, contains detergent.
Domestic (Volume)	98,320 Gal/Mo	52,940 Gal/Mo	21,180 Gal/Mo	4,950 Gal/Mo	32,650 Gal/Mo	210,540 Gal.Mo	Discharged into water with no treatment.
(5-Day B.O.D.)	2,800 Lbs/Mo	1,500 Lbs/Mo	660 Lbs/Mo	140 Lbs/Mo	925 Lbs/Mo	5,960 Lbs/Mo	

could amount to 1000 tons or 7000 bbl or 300,000 gallons on a single voyage of a 200,000 ton tanker. The heavier sludge in the tank bottoms was already well on its way to becoming the tarry residue on the shore.

Environmental concern plus the value of the lost oil have led to newer techniques such as the load on top technique, crude oil washing, and segregated ballast which greatly reduce operation discharges.

Based on the Caribbean traffic alone, the reduction in loss from 1/200 of the cargo to 1/15,000 of the cargo allowed under the 1969 IMCO Convention would reduce tank washing discharges from 1 million tons to approximately 16,700 tons of discharge per year.

With the large number of mid-sized and handy-sized tankers used in the Wider Caribbean, the possibility of the less efficient methods of tank washing being used is high. Learning more about such practice is necessary as part of any Caribbean control program.

In view of the Caribbean exposure to residues from the European tanker trade in the Atlantic, the Caribbean program should carefully study the practices being following in the Atlantic. It is in the best interest of the Caribbean to support international efforts to reduce these operational discharges.

SECTION 5

VULNERABLE ENVIRONMENTAL SYSTEMS IN THE WIDER CARIBBEAN REGION

The scope of this study does not permit a detailed evaluation of the environmental systems of each of the coastlines of the individual countries in the wider Caribbean system. In this section of the report the various types of environmental systems found in the wider Caribbean region are discussed as will be their relative susceptibility to oil impact.

The effects of oil spills and their impact will vary with the composition of oil, extent of the spill, sensitivity of the target species, life history stages involved, general environmental conditions, and the presence of other pollution. Little is known about the actual toxicity levels of the various crudes and petroleum products in relation to the species of biological life native to the Gulf coast and the Caribbean regions. However, aquatic and biological environmental systems and their susceptibility to oil impact are discussed.

For the purposes of this report the environmental systems are discussed under three interrelated groups, namely coastal systems, aquatic systems, and types of organisms exposed. Subheadings in these three groups are shown below.

Coastal Systems

Salt marshes and mangroves
Sheltered tidal flats
Sheltered rocky coasts and coral reefs
Gravel beaches
Mixed sand and gravel beaches
Exposed, compacted tidal flats
Coarse-grained sand beaches
Fine-grained sand beaches
Eroding wave cut platforms
Exposed rocky headlands

Aquatic Systems

Bays and Lagoons
Open seas
Coral zone
Benthic zone
Surf zone

Biological Systems

1. Mammals
2. Reptiles
3. Waterfowl
4. Shellfish
5. Phytoplankton and Zooplankton

Each of the various types of coastal, aquatic and biological systems will be discussed. Biological systems will be discussed separately, but will be mentioned in the discussions on coastal and aquatic systems where applicable. The information on areas of likely oil spills from production and transportation related activities presented in Sections 3 and 4 are analyzed in this section in light of the general meteorological and oceanographic trend presented in Section 2 to indicate the environmental systems most likely to be impacted from future spills.

Coastal Systems Vulnerable to Oil Impact in the Wider Caribbean Region

Different types of coastal systems are impacted by oil brought in contact to the shore. Spill vulnerability is based on shoreline interaction with the physical processes controlling oil deposition, persistence or longevity of the oil in that environment, and the extent of biological damage to the environment.

A useful analysis by Miles Hayes considers the various coastal systems and their arbitrary relative vulnerability. These systems are discussed below in increasing order of vulnerability.

1. Exposed Steeply Dipping or Cliffed Rocky Headlands

Most areas of this type undergo intensive wave energy usually inducing a return flow from the rocks. The return flow would generally keep oil off the rocks in the event of an oil spill. Natural cleanup on this type of system has been observed to be rapid possibly due to a low contamination level. As a result, control is usually unnecessary in these areas.

2. Eroding Wave cut Platforms

These areas include narrow wave swept beaches located in front of deposited material.

3. Flat, Fine-grained Sandy Beaches

These types of beaches usually have a flat profile and are hard packed, allowing traffic to move over the beach. Grain size is from 0.0625mm to 0.25mm. Several studies have indicated that damage from oil spills have occurred to amphipods, surf clams, and the neofauna organisms that live in between the sand grains.

The fine grained sand limits the penetration of oils to a few centimeters below the surface. In removing oil, caution must be taken to wait until the oil is on the beach, avoid repeatedly driving over the beach, which may further grind the oil below the surface, and remove minimal amounts of sand to minimize beach erosion. Sand should be replaced if necessary to prevent erosion of the impacted beach or those elsewhere on the coast.

4. Steeper, Medium-to-Coarse Grained Sand Beaches

These types of beaches have a grain size from 0.25 mm to 2.0 mm. They are present in many coastal environments including those of low energy beaches found along the Gulf of Mexico and higher energy beaches found in the Atlantic and Caribbean region. Typically, biological activity is relatively low. Oil may sink 15 cm to 25 cm into the sand, possibly being buried by natural processes at greater depths. Depths of 50 cm have been observed by Hayes,

Oil spill cleanup is difficult because of generally poor tracking across the loosely packed sand. High energy beaches can also remove oil that they have buried over a period of months. Oil deposited due to above normal wave action during storm surges and high spring tides should be removed. Removal should also take place on the beaches which experience little wave action.

5. Exposed, Compacted Tidal Flats

These tidal flats are compacted, fine-grained sand or mud and relatively exposed to winds, tides, waves and currents. Oil does not penetrate or adhere to the flats. Biological activity is usually extensive, readily degrading oil that may be present. Infaunal organisms include polychaeti, nematode worms, and mollusks. Moderate to heavy oil contamination can severely damage these communities.

6. Mixed Sand and Gravel Beaches

Beaches of this type are usually located in medium to high energy environments. Shored oil penetrates the beach 10 to 20 cm sometimes within a few days.

7. Gravel Beaches

Gravel beach grain size is greater than 2 mm. Oil penetrates rapidly into this type of beach. Oil penetration into fine gravel beaches has been reported at 60 to 80 cm. Cleaning beaches of this type is hard to do without removals of large amounts of material moderately to heavily oiled. Removal of excessive material may cause adverse effects to the long term stability of the beach. Biological activity is often extensive and diverse in the sublittoral zone. Sinking and penetration of oil can be highly damaging to biological activity.

8. Sheltered Rocky Coasts

These types of shoreline have numerous coves and protected embayments along the rocky coastline. Wave activity in the areas range from low to moderate depending on the degree of protection. In some areas, oil will degrade fairly rapidly, whereas, in others the oil can remain for years. The biological community in this type of environment include algae, mollusks, crustaceans, and infaunas. These and other communities occur extensively are vulnerable to oil spill damage.

9. Sheltered Estuarine Tidal Flats

Protected or sheltered tidal flats are common along the Gulf coast. Since biological productivity is usually high with large populations of mollusks and polychaete worms, oil spilled in this type of coast may have long term adverse effects. Oil should be prevented from entering these types of areas using diversion booms, by closing off the estuary entrances or by other effective means.

10. Sheltered Estuarine Salt Marshes and Mangrove Coasts

These types of systems are among the most productive of all coastal environments. Delicate balances between plant and organisms are maintained in the environment. These types of areas frequently serve as spawning grounds for sport and commercial fish. Important food sources for many marine organisms are found in detritus from the marsh. Heavy oil can cause detrimental effects to the balance of the biological system, sometimes for years.

Mangroves are extensive along the Gulf and Caribbean shorelines. These areas also represent diverse and extensive biological activity and are relatively easily damaged when heavily oiled. Removal of oil from the mangrove root system to help assure recovery is necessary but difficult.

Salt marshes and mangrove shorelines are environments to be protected from oil if at all possible. Table 5-1 summarizes the ten coastal systems arbitrarily ranked by Hayes in order of increasing vulnerability to oil spill damage. This table also summarizes comments on the susceptibility of each system to oil spill damages.

Using the method described by Hayes (28), shoreline types for an area can be assessed using the vulnerability index. The percentages of lengths of the various types of coastal shorelines relative to the total coastal shoreline length are estimated. Table 5-2 illustrates this method for three geographical regions common to coastal shorelines. The lengths and percentages are for a hypothetical coastline and are presented to illustrate the method discussed. Figure 5-1 represents the application of the vulnerability index for the hypothetical coastline information presented in Table 5-2. The same type of technique can be applied to

TABLE 5-1

SUMMARY OF COASTAL SHORELINE SYSTEMS IN ORDER OF INCREASING

VULNERABILITY TO OIL SPILL DAMAGE*

Vulnerability Index	Shoreline Type	Comments
1	Exposed rocky headlands	Wave reflection keeps most of the oil off-shore.
2	Eroding wave-cut platforms	Wave swept. Most oil removed by natural processes within weeks.
3	Fine-grained sand beaches	Oil doesn't penetrate into the sediment. Otherwise, oil may persist several months.
4	Coarse-grained sand beaches	Oil may sink and/or be buried rapidly. Under moderate to high energy conditions, oil will be removed naturally within months from most of the beach face.
5	Exposed, compacted tidal flats	Most oil will not adhere to, nor penetrate into, the compacted tidal flat.
6	Mixed sand and gravel beaches	Oil may undergo rapid penetration and burial. Under moderate to low energy conditions, oil may persist for years unless physically removed.
7	Gravel beaches	Same as above. Cleanup should concentrate on the high-tide swash area. A solid asphalt pavement may form under heavy oil accumulations.
8	Sheltered rocky coasts	Areas of reduced wave action. Oil may persist for many years if not physically removed.
9	Sheltered tidal	Areas of great biologic activity and low wave energy. Oil may persist for years if not physically removed.
10	Salt marshes and	Most productive of aquatic environments. Oil may persist for years if not physically removed.

* Source: Vulnerability of Coastal Environments to Oil Spill Impacts

TABLE 5-2

SHORELINE MORPHOLOGY FOR THE HYPOTHETICAL COASTLINE INDICATED IN FIGURE 5-1

A. Erosional Shorelines (32% of the total)

Subclasses	Total Shoreline (km)	% of Total Shoreline	Vulnerability Index
A1. Cliffs >30 m high with wave cut platform	15	19	1-2
A2. Cliffs <30 m high with wave cut platform	6	8	1-2 (4%)
A3. Eroding back of inlet channel	4	5	7-8 (4%)

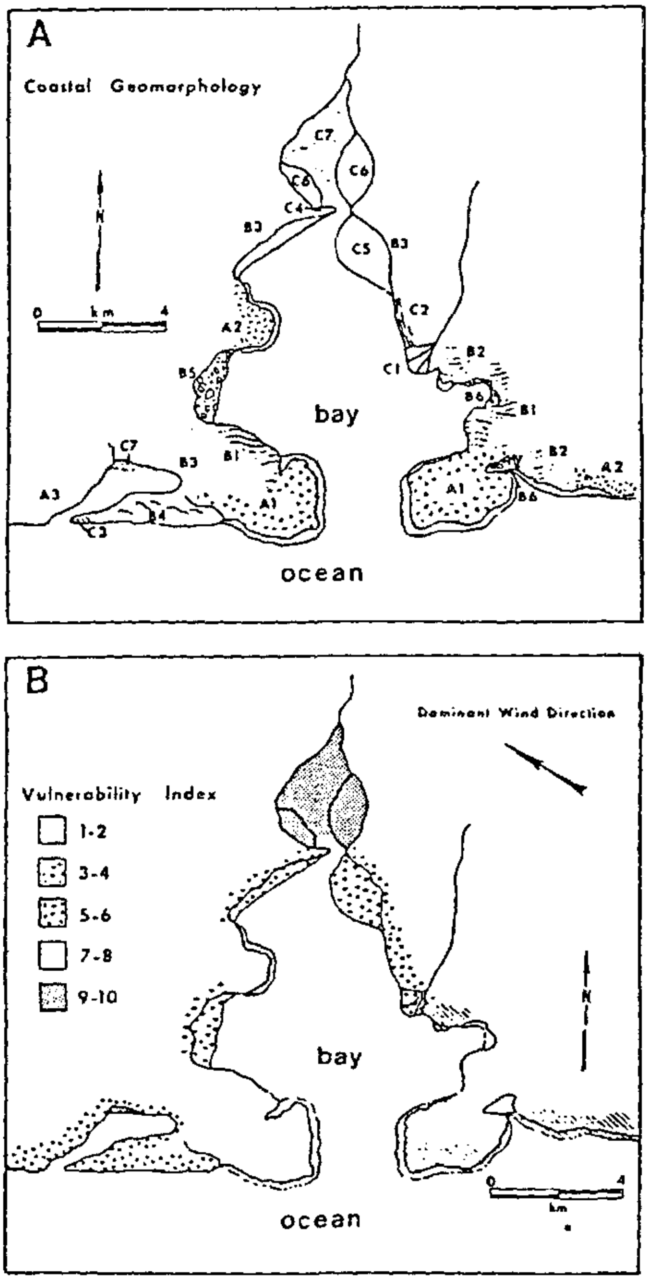
B. Neutral Shorelines (39% Of total)

Subclasses	Total Shoreline (km)	% of Total Shoreline	Vulnerability Index
B1. Mountainous with steep high scarps	5	7	7-8
B2. Hilly lowlands with low scarps	4	5	1-2
B3. Protected fine sand beaches	9	12	3-4
B4. Coarse sand beaches	6	8	3-4
B5. Mixed sand and gravel beaches	2	3	5-6
B6. Pocket gravel beaches	3	4	7-8

C. Depositional Shorelines (29% of total)

Subclasses	Total Shoreline (km)	% of Total Shoreline	Vulnerability Index
C1. Arcuate delta	1	1	3-4
C2. Beach ridges	2	3	3-4
C3. Recurved spit	1	1	3-4
C4. Bay mouth bar	1	1	3-4
C5. Sand tidal flat	3	4	5-6
C6. Mud tidal flat	5	7	9-10
C7. Salt marsh	9	12	9-10

FIGURE 5-1



A. Coastal geomorphology of a hypothetical shoreline.

B. Application of the Vulnerability Index to the shoreline types of Fig. 1A. In this model, 28% of the shoreline is classified as having a VI = 1-2, 31% has a VI = 3-4 (low risk areas), 7% has a VI = 5-6, 15% has a VI = 7-8, and 19% is classified as high potential oil spill damage with a VI = 9-10.

areas most likely to be impacted by spilled oil. These areas will be discussed in detail later in this section.

Aquatic Systems Vulnerable to Oil Impact in the Wider Caribbean Region

The aquatic systems in the wider Caribbean region are discussed using the following categories: bays and lagoons, open bay and open seas, surf zone, coral zone, and bottom zone. Each type of system will be discussed as it relates to oil pollution in the region.

Bays and Lagoons

Bays and lagoons are semi-enclosed bodies of water experiencing currents due to meteorological and tidal influences. These systems are directly or indirectly in connection with marine waters. The areas are usually biologically productive and sensitive to oil pollution adverse effects. Vulnerability indices using the Hayes system for these types of areas may vary from 7 to 10.

A large portion of the Texas Gulf coast estuaries are separated from the open waters of the Gulf of Mexico by a series of barrier islands extending up and down its coastline. Figure 5-2 shows the Texas barrier islands system. There are seventeen passes, shown in this figure, through the barrier islands; many of them dredged for shipping traffic.

Currents through these passes can be in excess of 1 meter/sec., depending on the local tide and wind conditiond. Bays and lagoons are typically shallow with large surface areas and relatively small tidal ranges.

Bays and lagoons are found throughout the Caribbean region on many

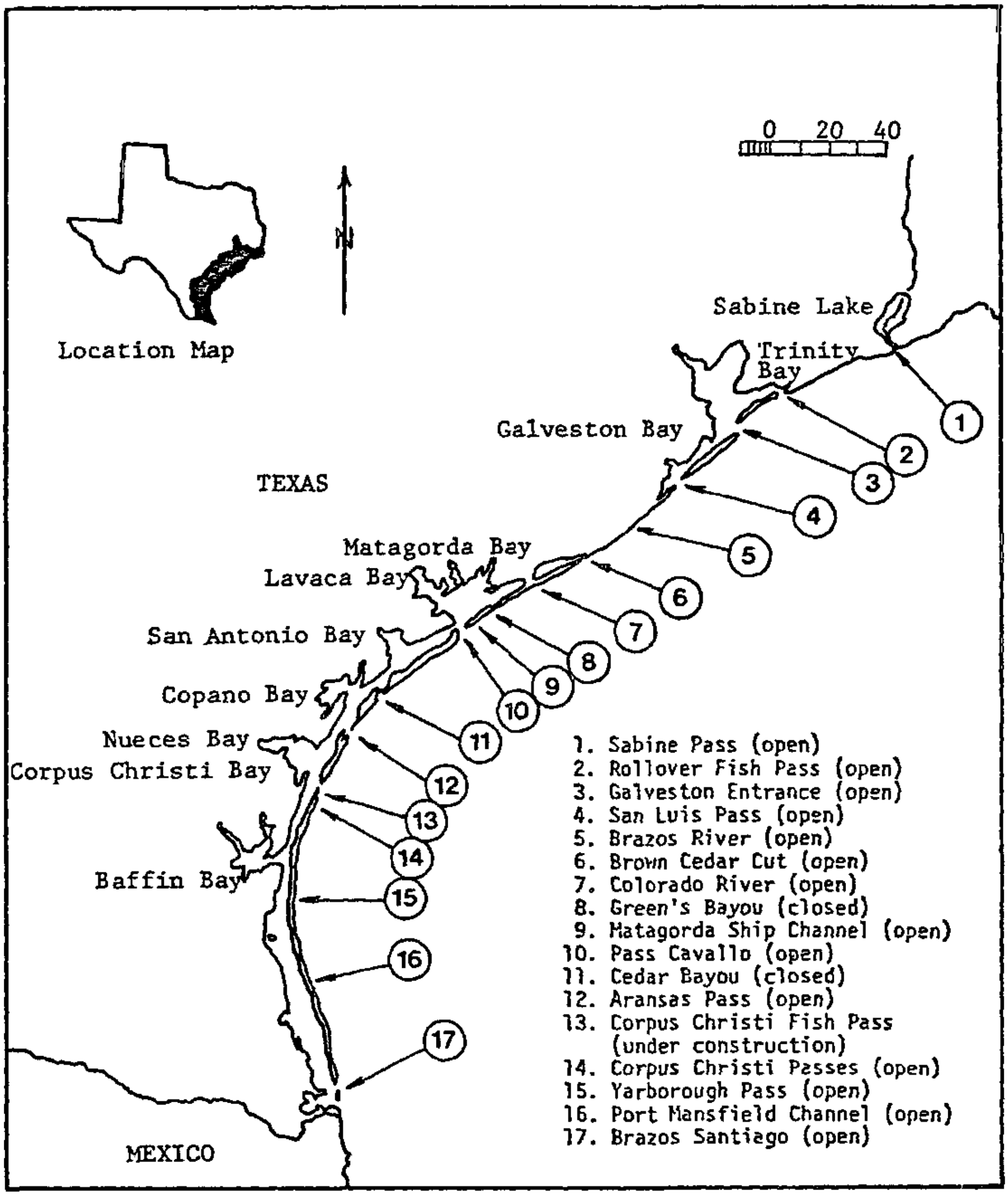


Figure 5-2. Example of Laguna System and Barrier Islands showing locations of Texas Coastal Passes

large island and mainland country coastal environments such as those found in Venezuela, Colombia, Trinidad, Puerto Rico, Dominican Republic, and others. Spilled oil coming in contact with this type of environment should be avoided if possible. This is due to the importance of these systems as shellfish and sport or commercial fishery, spawning and nursery areas and as generators of the primary and secondary productivity organism which feed the marine food chain. The shallow water brings the oil into close proximity with the organism and thus these areas are especially sensitive to oil spill damage. In addition, wildlife, waterfowl, mammals and reptiles are sensitive to oil in bays and lagoons.

Oil movement in the bay and lagoon system is primarily dependent on meteorological conditions. The depositon of oil will depend on the relief and slope of the shoreline and tide water elevation.

Harbors

The sizes and vessel capacities of harbors vary. Within harbors three problem areas exist with regard to the amount of oil present in the harbor aquatic system. These problem areas are: (1) shipping operations, (2) harbor operations, and (3) harbor approaches.

Shipping operations within a harbor account for some of the oily water usually present. Oily wastes are usually due to petroleum product transfer operations related accidents, ballast oily waste discharges, and accidental oil spills. Figure 5-3 shows the ballast and tank washing high risk areas, In addition, port operations problems that exist include oily waste water, and storm runoff control for large operations. Oil pollution may result indirectly as a result of less than 100% removal of oil in ballast water after treatment. The treated waste water is usually

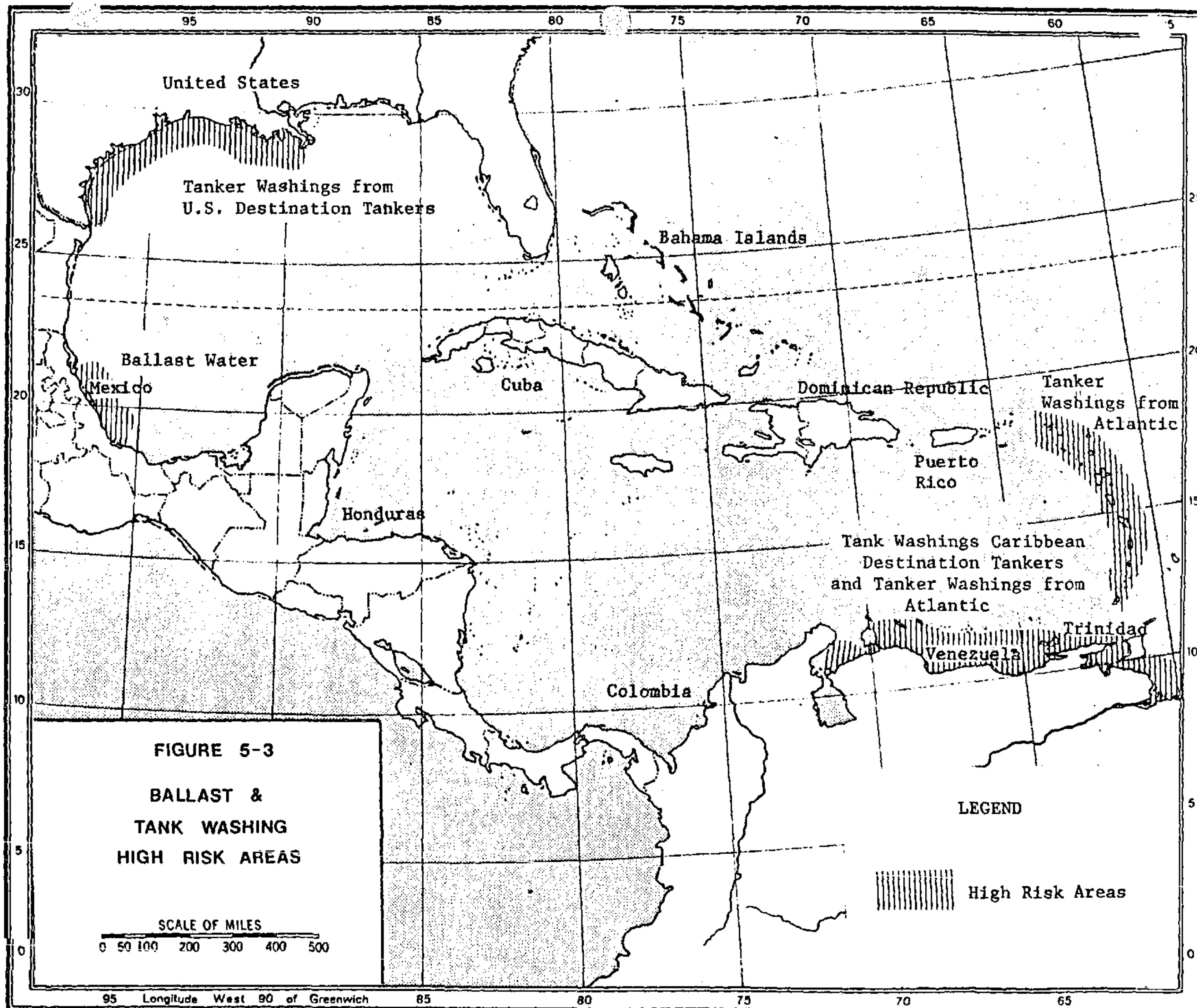


FIGURE 5-3

BALLAST & TANK WASHING HIGH RISK AREAS

discharged into the harbor.

The local coastal features of many wider Caribbean harbors and ports make entry into them difficult. In many cases, deeper and wider channels have been dredged and navigation markers and lights positioned to minimize the possibility of accidents while approaching a harbor. Figure 5-13 shows the harbors in the wider Caribbean that are considered to have high risk approaches. The reasons for the designation of high risk approaches are presented later in this section of the report.

Some organism and plant life that are present in some harbors become adapted to the chronic oil pollution levels that may exist in these environments.

Harbors are often natural catch basins for oil spills because of their relative quiescent conditions. The uncontrolled movement of large amounts of oil within these facilities may cause damage to docked vessels. The removal of oil from small craft is expensive laborious. Large amounts of oil within a harbor will remain until removed, under most conditions.

Open Seas

The term pelgaic refers to the waters of the world's oceans. The pelgaic is divided into the neritic province or water overlaying the continental shelf and the oceanic province or the rest of the water seaward off the continental shelf.

The upper 200 meters of the ocean is the zone most affected by an oil spill.

There are some very basic differences between the environmental conditions of the neritic and oceanic provinces even though they tend to overlap. In the open ocean, the physical conditions do not vary a great deal. The salinity remains constant at approximately 35,000mg/l and the major sources of variation are rain, which lowers the salinity and evaporation which causes an increase in the salinity of the surface water. One of the important properties of seawater which is of interest in an oil spill is the density of water. Seawater has a density of 1.02 to 1.03 and in the ocean the density is dependent on the temperature and the salinity. Therefore, as the salinity decreases and the temperature increases, the density of the seawater increases and vice versa.

The waters of the neritic province (water over the continental shelf) are 200 meters in depth or less and thus this region is much more variable than the open ocean region because of the shallowness of depth, the influx of fresh water from river runoff, and a higher loading of suspended sediments. The influx of fresh water with its high level of nutrients makes the neritic region the most productive of the two pelgaic regions.

For the most part, catastrophic effects from an oil spill are not expected in the open ocean environment, primarily as a result of the rapid dispersion and degradation of the oil and the general low vulnerability of open ocean organisms to contact with oil. For example, damages to small populations of phyto and zooplankton depend mostly on the chance event of encountering a floating slick; however, once contact occurs and organisms are killed, numbers are generally quickly restored as a result of fast rates of reproduction and immigration.

The term Neuston refers to those organisms which live at or near the surface of the water. Since they live very close to or at the surface, they are very vulnerable to an oil slick. Of particular importance are the larvae and post-larval stages of shrimp and other organisms which float to the surface during part of the development cycle and are particularly sensitive to oil.

The term Nekton refers to that community of animals which are capable of rapidly moving themselves vertically and horizontally within the water column. Specific animals which make up this group are the fish, squid, whales, other sea mammals, sea snakes, and other larger marine animals. The major members of this group are the fish species, which are of vital importance as a food source for much of the world and which may become contaminated with oil by feeding on contaminated organisms or by feeding in contaminated waters.

Coral Zone

Coral systems are diverse biological systems which range from the living coral substrate itself to the wide range of organisms which live on or around it. The coral system also serves a valuable role in protecting island systems from the eroding force of the sea. The destruction of the living bond of protection would ultimately lead to the destruction of the protected islands. Relatively little is known about the susceptability to damage of these systems, but the nature of the organisms known to be present would cause most scientists to assign a Hayes rating system number of 10 and to recommend practices to keep floating oil away from coral and to avoid any action in the area which would cause oil to become dispersed into the water and thus in close contact with the coral community.

Benthic Zone

The benthic zone of the coastal and deep ocean system includes those organisms living on the bottom from the sublitoral to the deep ocean. Of greatest concern are those bottom areas in relatively shallow coastal sy$tems where light penetration occurs to the bottom. These areas are relatively lightly effected by oil floating past on the surface, but they are drastically impacted if the oil is carried to the bottom by either an applied sinking agent or by deposition of natural sediment coated with oil, or conversly mousse deposits weighted naturally by beach sand or other sediments.

Surf Zone

Surf zone is more of an engineering term used to refer to the intertidal area and the shallow supratidal area where the wave action against the sand or rocks mixes the oil and sand together. The oil-sand combination then sinks in this area disturbing those marine organisms living in this zone.

Biological Systems Vulnerable to Oil Impact in the Wider Caribbean Region

The biological communities found in the wider Caribbean region provide many basic needs for coastal and inland populations in the region. The biological communities affected include mammals, reptiles, waterfowl, mollusks, sea grass, crustaceans, polychaetes, zooplankton, phytoplankton, and finfish. There exists a sensitive balance among these biological communities.

Oil pollution, whether it be due to the spill or discharge of a crude oil or a refined product, may damage the marine environment many different ways, among which are:

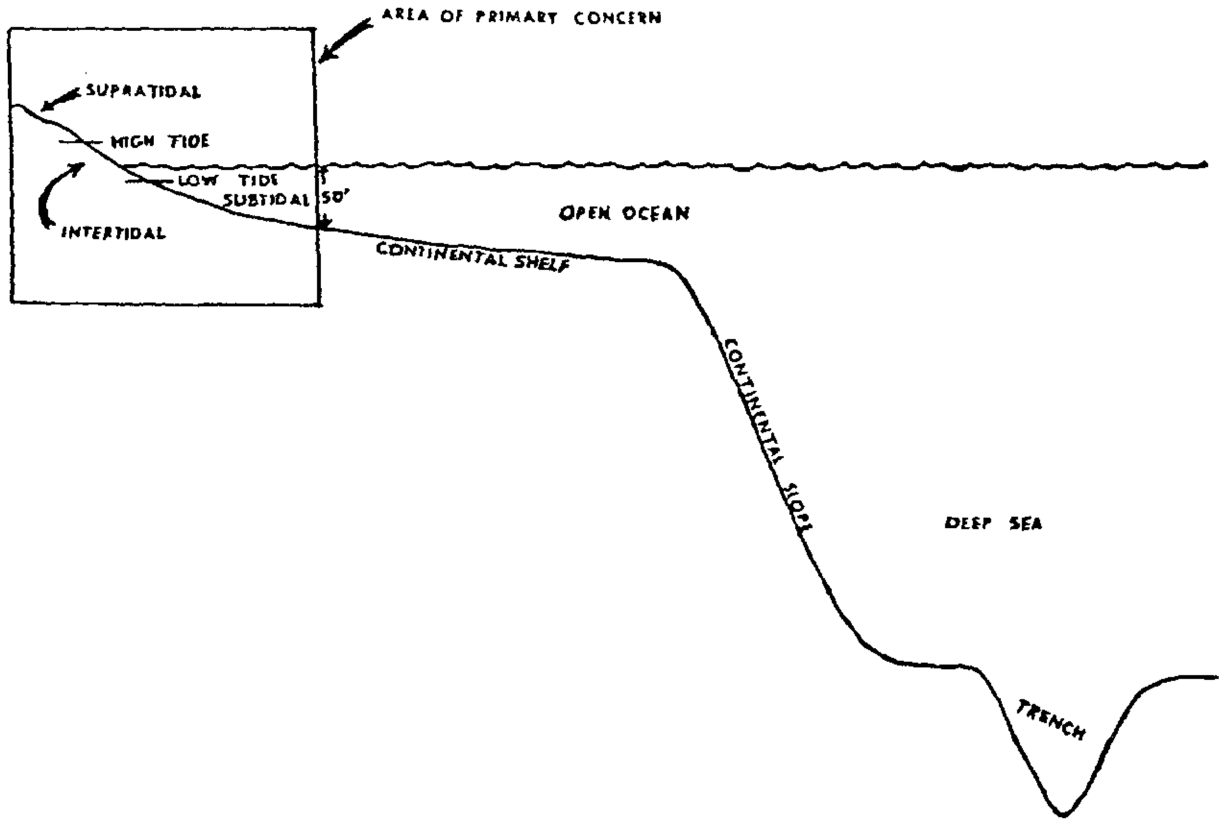
1. Direct kill of organisms through coating and asphyxiation.
2. Direct kill through contact poisoning of organisms.
3. Direct kill through exposure to the water-soluble toxic components of oil at some distance in space and time from the accident.
4. Destruction of the food sources of higher species.
5. Destruction of the generally more sensitive juvenile forms of organisms.

6. Incorporation of sublethal amounts of oil and oil products into organisms resulting in reduced resistance to infection and other stresses (the principal cause of death in birds surviving the immediate exposure to oil).
7. Destruction of food values through the incorporation of oil and oil products, into fisheries resources.
8. Incorporation of carcinogens into the marine food chain and human food sources.
9. Low level effects that may interrupt any of the numerous events necessary for the propagation of marine species and for the survival of those species which stand higher in the marine food web.

In general, the biological communities most affected by oil spills exist in three distinct coastal habitats or zones. These zones are called supratidal, intertidal, and subtidal. The supratidal zone is onshore above the spring high water. Figure 5-4 shows the zonation in the marine environment. Mammals, reptiles, and waterfowl are found in the supratidal zone.

The intertidal zone is onshore between spring high water and spring low water. Three general types of habitats exist in the intertidal zone. These types are rocky, sandy, and marshy. Rocky habitats occur where wave action is on vertical extending rocky shores, jetties or sea walls. Figure 5-5 shows the zonation of organisms typically found on rocky shores.

Mollusks, such as snails, are present in the upper intertidal rocky shore areas. Crustaceans such as barnacles are located in the mid-intertidal zone. Sea grasses and many small organisms are found in the lower intertidal zone.



ZONATION IN THE MARINE ENVIRONMENT

FIGURE 5-4

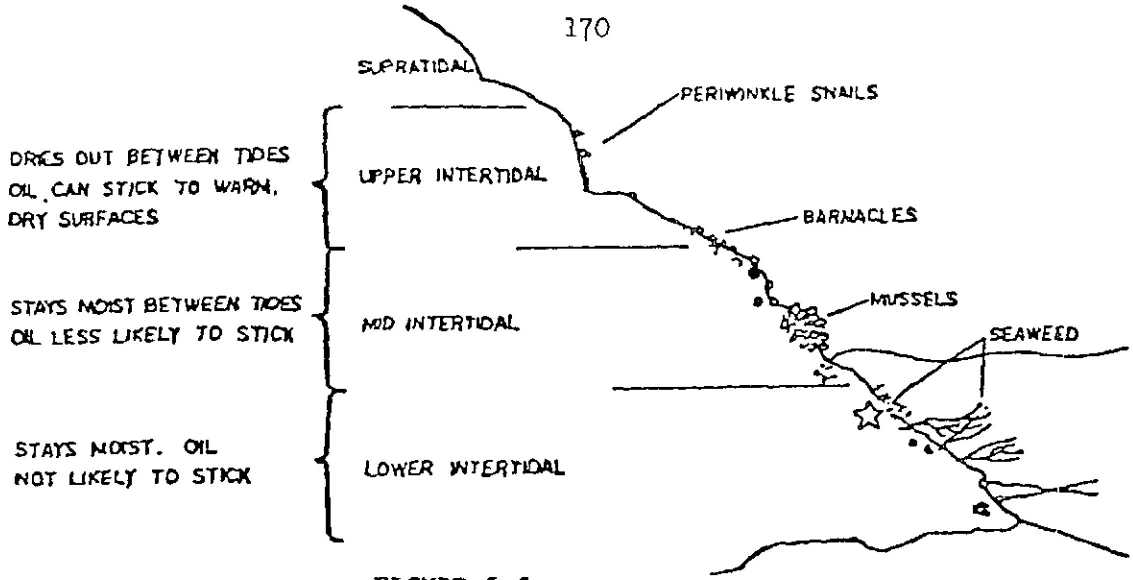
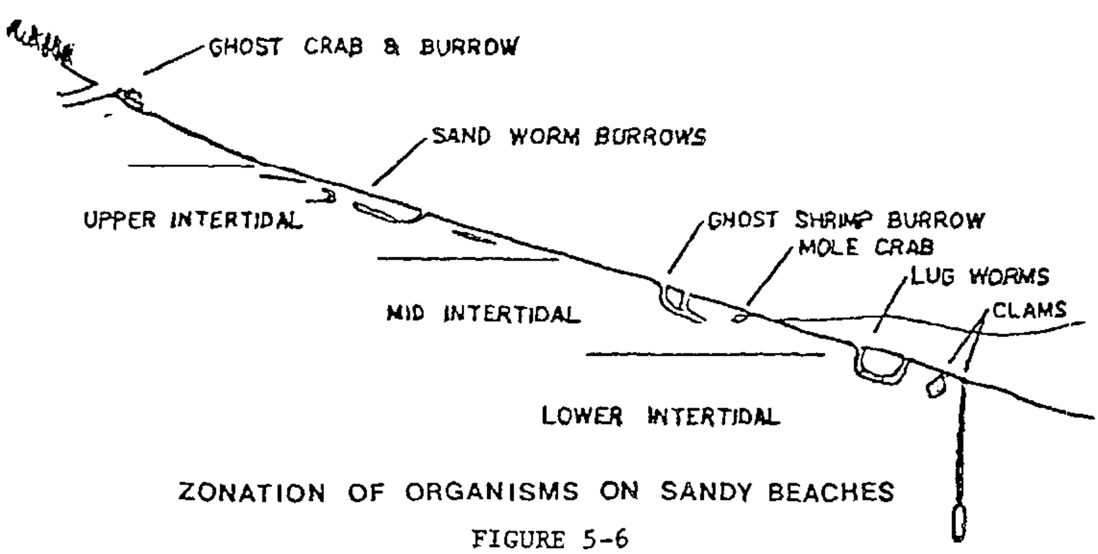


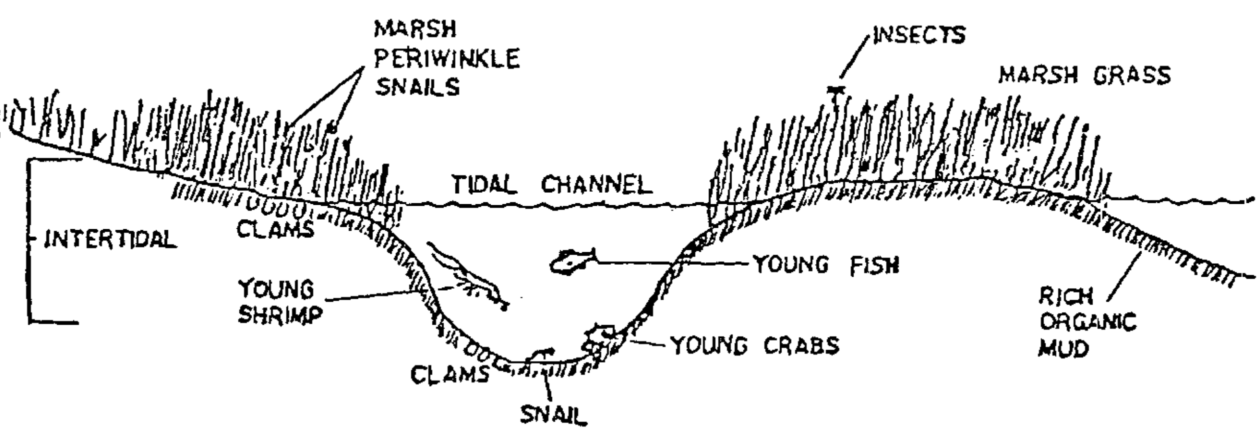
FIGURE 5-5

ZONATION OF ORGANISMS ON ROCKY SHORES



ZONATION OF ORGANISMS ON SANDY BEACHES

FIGURE 5-6



TYPICAL MEMBERS OF A MARSH ECOSYSTEM

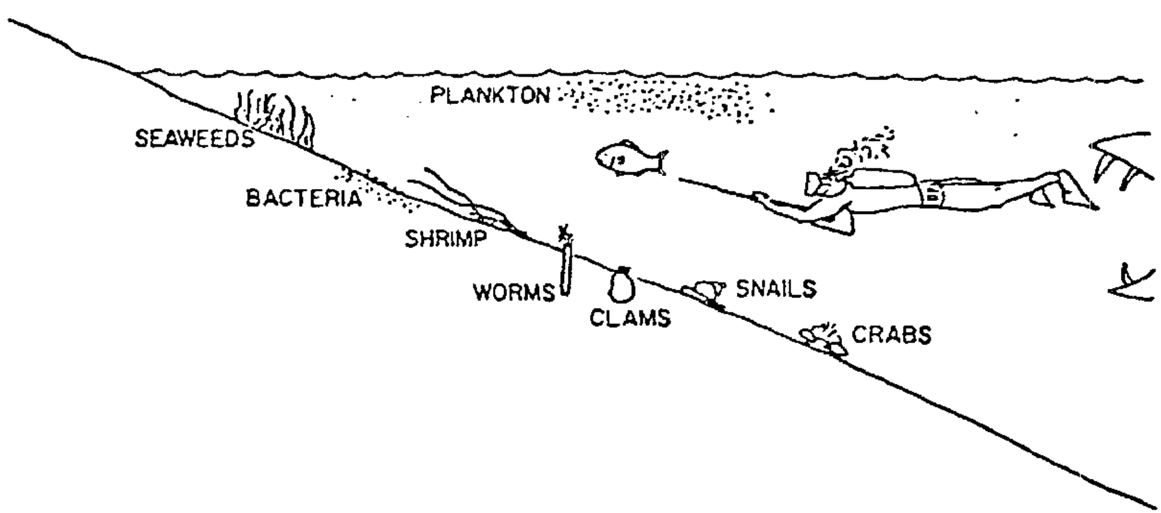
FIGURE 5-7

Sandy shore intertidal zone occurs when wave action keeps clay particles from settling and allows only the heavier sand grains to remain on the beach. Figure 5-6 shows the sandy beach and the zonation of organisms in this habitat. The upper intertidal zone may have small crustaceans, such as crabs and polychaetes. The mid-intertidal zone has other small crustaceans including crabs. The lower intertidal zone is where mollusks such as clams are located.

The marsh habitat is the most diverse habitat for biological communities. Crustaceans, such as shrimp, clams, and lobster are present in many bays surrounded by marshland. Mollusks such as snails and clams are found in addition to finfish. Extensive marsh grass or mangroves will usually be present in this type of habitat. Figure 5- 7 shows a diagram representing typical members of a marsh ecosystem.

The intertidal zone is divided into upper, mid and lower intertidal areas. The upper intertidal becomes wet during high tide and dries out between successive high waters. Oil sticks readily and thick accumulations can occur on dry surfaces. The mid-intertidal zone is generally moist when the tide is out, providing the oil less chance to adhere. The populations of organisms are relatively higher in this area compared to the upper intertidal area. The lower intertidal area stays wet at all times due to wave action. Oil on the wet surface stands less chance of sticking. This layers are usually formed if oil does stick. The lower portion of the lower intertidal zone is usually submerged all of the time exposing organisms to the hydrocarbon fractions dissolved in the water column.

The subtidal zone begins at the spring low water mark and extends out to sea including bottom sediments and the ocean waters above. This zone is always underwater as shown in Figure 5-8. The subtidal zone especially important to this report is that zone where the water depth is less than about 15 meters. This zone is very important for the commercial seafood species such as shrimp, clams, crab, lobster, abalone, and scallops. Plant life also exists in the form of plankton and sea grasses. Exposure to oil in this zone can be from dissolved or sinking oil.



Organisms of the Subtidal Zone

FIGURE 5- 8

Mammals

Relatively few observations of any direct effect of oil spills on larger marine mammals such as whales, seals, and sea lions have been made. These animals appear to be able to sense and avoid oil on the surface of the water.

In 1974 at the University of Guelph, Ontario, Canada, a study was made of ringed seals. They were either placed into crude-oil-covered water, brush-coated with oil, or given oil by mouth. Twentyfour hour surface exposure to light crude oil was damaging only to the eyes of healthy seals, whereas stressed seals died within 71 minutes of exposure. Oil in quantities reasonably expected to be ingested during an oil spill was not irreversibly harmful. It was determined that the consequences of an oil spill ultimately depend on the season of spill, productivity of the area, and the variable health status of a seal population.

Reptiles

Reptiles subject to oil damage are turtles, alligators, and sea snakes. Damage to onshore hatching grounds may result. For example, oiled beaches may prevent the newly hatched turtles from reaching the water.

The Ridley turtle, a rare and endangered species is found in the Texas and Mexico Gulf Coast areas.

Waterfowl

The casualty rate of waterfowl is often very high when an oil spill occurs. Marine birds, especially diving birds, appear to be the most vulnerable to the effects of oil spillage, but any bird that feeds from the sea or settles on it is vulnerable. In oil-matted plumage, air is replaced by water causing loss of both insulation (body heat) and buoyancy, and oil ingested during preening can have a toxic effect.

The possible effects of the spillage on the bird population will vary with the season. For example, young birds during the late nesting season and flightless adults during the moulting season may be particularly vulnerable along the shore. Conversely, various groups of migratory birds may avoid exposure because of their absence at the time of the spill. Nonmigratory birds will be the hardest hit with the possibility of eliminating an entire colony.

Several areas exist throughout the wider Caribbean region where endangered specied are observed. These areas are of particular concern to protection from oil contamination. Refuges have been established along many coasts to help restore the numbers of species considered to be endangered. For example, the rare whooping crane has a wintering ground at Aransas National Wildlife Refuge in Texas, one of several refuges along the Gulf Coast.

Finfish

The wider Caribbean region ocean waters have a variety of dimersal resources including snapper, grouper, sea bass, drum, croaker, and hake.

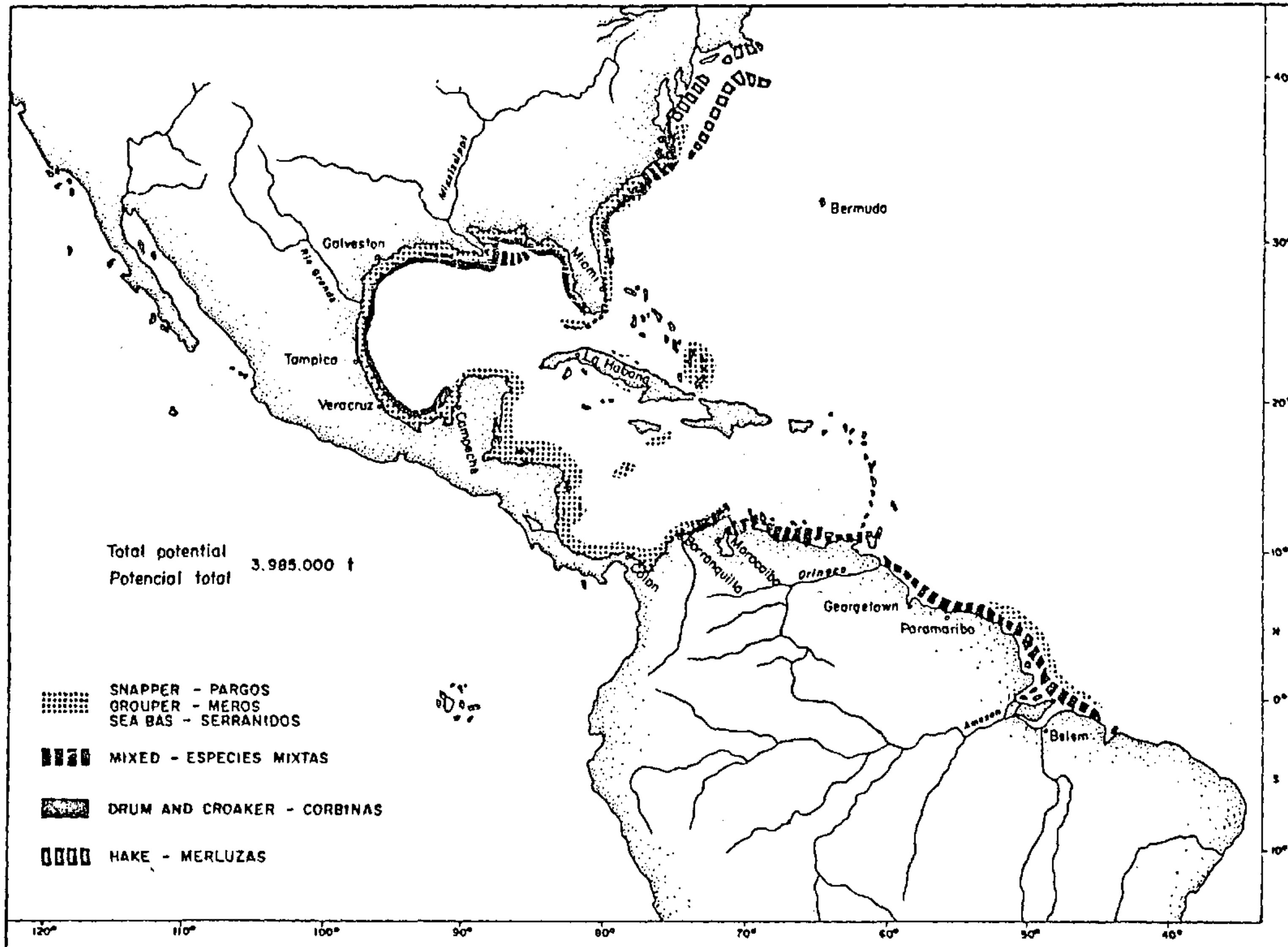


Figure 5-9
West Central Atlantic demersal resources. (From: FAO, Atlas of Living Resources of the Sea, 1972)

Finfish generally appear to be unaffected by the presence of spilled oil as their mobility permits then to avoid areas with high oil or chemical concentrations. Danger to fish is probably limited to possible harm to eggs, larvae, or juveniles which seasonally may be found concentrated in the upper waters or in shallow areas nearshore.

A map of demersal resources in the Wider Caribbean are shown in Figure 5-9.

Shellfish

Shellfish including mollusks such as clams, oysters and scallops along with crabs, lobsters, and shrimp appear to be the segment of marine life most directly affected by oil spillage in the coastal zone. Most of these types will survive contamination by heavy oil alone, however the flavor of the flesh will be tainted. Lighter petroleum fractions such as diesel or gasoline appear to be more fatal, and some species such as clams may experience significant mortalities. Fortunately, in most spill incidents, the effects on shellfish appear to be fairly temporary, and even in those situations where high mortalities were observed at the time of the incident, recovery appears to have taken place within a period of six months to two years.

A map showing the crustacean resources in the wider Caribbean area is shown in Figure 5-10.

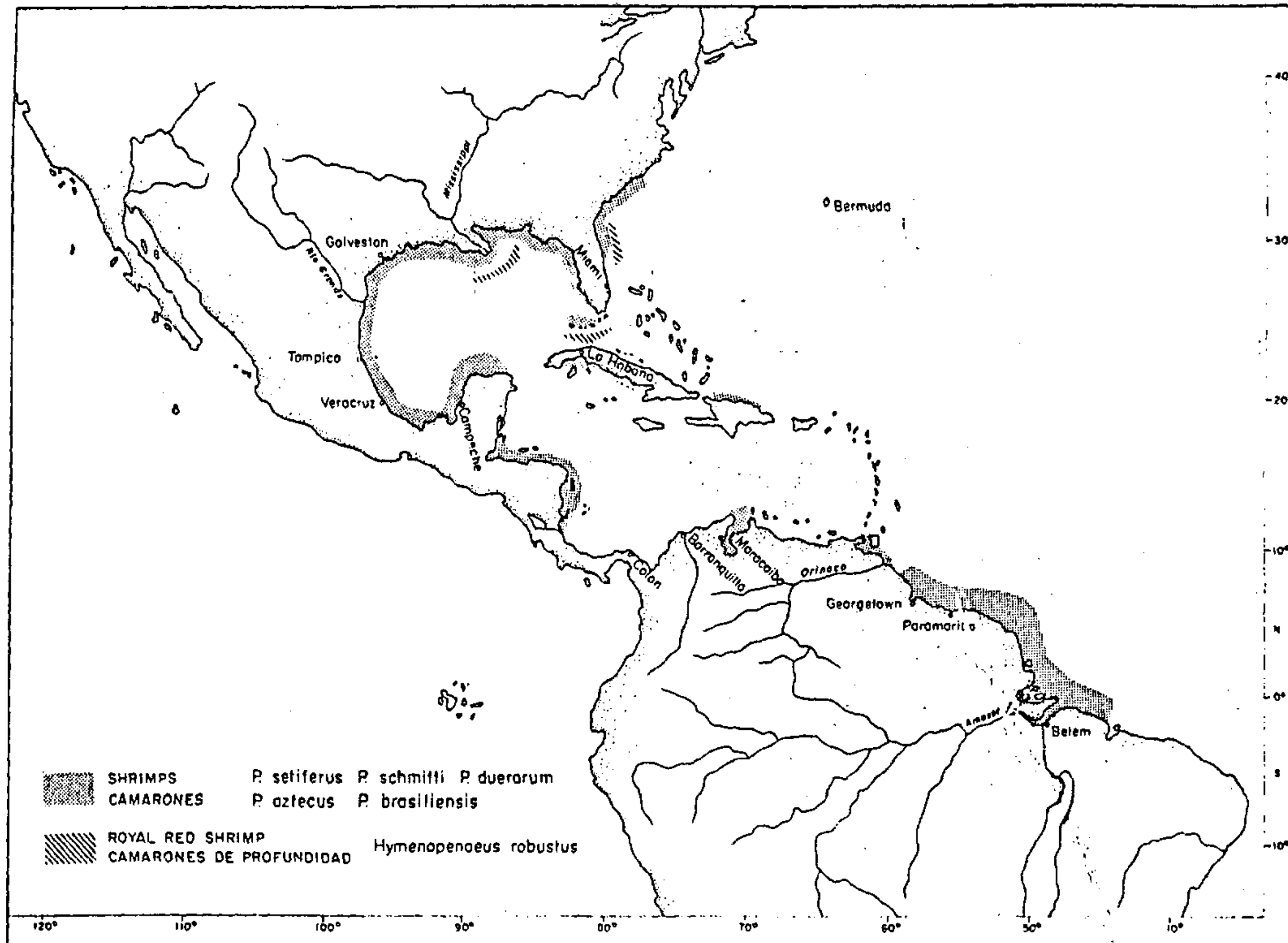


Figure 5-10
West Central Atlantic crustacean resources. (From: FAO, Atlas of the Living Resources of the Sea, 1972)

Phytoplankton and Zooplankton

Phytoplankton are responsible for the fixation of energy in the marine environment in that they produce food and oxygen. These small organisms use sunlight to convert chemicals in the water to living plant material releasing oxygen in the process. Phytoplankton communities are found offshore throughout the wider Caribbean area and represent an important link in the foodchain. Phytoplankton moves with wave motion and induced currents and therefore cannot escape contamination by their own propulsion.

Zooplankton are small animals that feed on living and dead phytoplankton. They in turn are eaten by other organisms.

The existence of both phytoplankton and zooplankton is seasonal and depends on the available sunlight. Oil spills may cut off sunlight, thus killing this important link in the food chain.

Potential Zones of Impact in the Wider Caribbean Region

Oil pollution occurs in the wider Caribbean in four types of risk zones. The probability of the occurrence of oil spills are greater in the areas which include offshore production accident risk zones; through shipping risk zones; terminal, refining and transhipping risk zones; tank washing and oily ballast discharge risk zones; and harbor approach high risk zones. These zones are called high risk zones and are listed for the wider Caribbean region in Table 5-3, except harbor approach high risk zones. For each high risk zone listed, the likely points of impact are also included in this table. The likely points of impact represent areas to which spilled oil will move based on information provided in Section 2, Section 3 and Section 4 of this report.

Offshore Production Accident High Risk Zones

Offshore production in the wider Caribbean is discussed in Section 3. The offshore production areas from Section 3 are listed in Table 5-3. These areas are shown in Figure 5-11. The likely zones of impact from oil spills for these areas includes the western and southern coastlines of the Gulf of Mexico and the Venezuelan Caribbean coastline.

Through Shipping High Risk Zones

The through shipping high risk zones listed in Table 5-3 represent areas in the wider Caribbean that experience large volumes of tanker traffic. These zones were established based on information on shipping lanes provided in Section 4 of this report. Figure 5-12 indicates the locations of these high risk zones. The likely zones of impact include almost all of the westward Antilles, all of the Netherland Antilles and the coast of Venezuela. Other

TABLE 5-3

ZONES OF HIGH RISK TO OIL SPILLS AND LIKELY POINTS OF IMPACT

High Risk Zone	Likely Zone of Impact
Offshore Production Accidents	
Texas	Texas coastline
Louisiana	Louisiana and Texas coastline
Mexico (North)	Northern Mexico and Texas
Mexico (Campeche)	Southern Gulf Coast, Northern Mexico or Texas
Trinidad & Tobago	Trinidad & Tobago , Grenada, Venezuela
Venezuela	Venezuela, Colombia
Through Shipping	
Anageda Passage	Virgin Islands, Puerto Rico, Hispaniola
Bahama Island Passages	Bahamas, Florida, Cuba, Haiti
Cayman Island Lightering	Cayman Islands
Florida Straits	Florida, north Cuban shore, Bahamas
Jamaica Channel	Haiti, Cuba, Jamaica
Lake Maracaibo	Venezuela
Mona Passage	Hispaniola
Netherland Antilles	Aruba, Curacao, Bonaire, Venezuela
Panama Canal Approach	Costa Rica, Nicaragua
Santa Lucia (north and south)	Santa Lucia, St. Vincent, Martinique, West Indies
Texas	Texas
Louisiana Gulf Coast Lightering	Texas, Louisiana
Tobago-Trinidad Channels	Trinidad, Tobago, Grenada, Venezuela
Windward Passage	Cuba, Jamaica, Caymans

TABLE 5-3 (continued)

High Risk Zone	Likely Zone of Impact
Yucatan - east	Yucatan Peninsula, Florida, Cuba
Yucatan - west	Yucatan Peninsula, Mexican Gulf, Texas, Louisiana
Port Approaches (refer to Figure 5-12 for numbered locations)	
Bahamas	
Freeport (1)	Bahamas, Florida
Nassau (2)	Bahamas, Florida
South Riding Point (3)	Bahamas, Florida
Barbados (4)	Barbados, Martinique, St. Vincent
Cuba	
Cabaiguan (9)	Cuba, Mexico, Yucatan Peninsula
Havana (10)	Cuba, Florida, Dominican Republic, Haiti
Santiago de Cuba	Cuba, Dominican Republic, Haiti
Dominican Republic	
Bonao (12)	Cuba, Dominican Republic, Puerto Rico, Haiti
Santo Domingo (14)	
Jamaica	
Kingston (17)	Haiti, Cayman Islands, Cuba
Mexico	
Coalzacoalas (19), Tampico (20), Tuxpan (21), Veracruz (22)	Southern and western Gulf of Mexico

TABLE 5-3 (continued)

High Risk Zone	Likely Zone of Impact
Port Approaches (continued)	
Netherland Antilles	
Aruba (23)	Aruba, Venezuela
Bonaire (24)	Aruba, Bonaire, Curacao, Venezuela
Curacao (25)	Aruba, Curacao, Venezuela
Panama	
Colon (26)	Colombia, Costa Rica, Nicaragua
Puerto Rico (27)	
Guayanita, Los Mareas, Port Yacuboa, San Juan	Dominican Republic, Puerto Rico, Virgin Islands
St. Lucia (28)	Martinique, St. Lucia, St. Vincent
Trinidad	
Brighton (29), Galeota Point (30), Point Fortin (31), Point a Pierre (32)	Trinidad, Tobago, Venezuela
U.S.A	
Corpus Christi, Texas (34), Port Aransas (42)	Texas
New Orleans, Louisiana (38)	Louisiana
Venezuela	
Altagracia (50), Amuay (51), Bachaquero (52), Bajo Grande (53)	Venezuela, Colombia
Capure (54), Carpito (55)	Trinidad and Venezuela
Virgin Islands	
St. Croix	Antigua, Dominican Republic, Puerto Rico

TABLE 5-3 (continued)

High Risk Zone	Likely Point of Impact
Tank Washings, Oily Ballast Discharge	
Tank washings from U.S. destination tankers, offshore lightering and harbors	Texas, Louisiana
Tank washings from tankers returning from Caribbean offshore lightering and harbors	Venezuela, Texas, Louisiana, Mexico
Tank washings from tankers returning from the U.S. east coast and from Europe.	West Indies, Venezuela, Trinidad, Tobago, Netherland Antilles

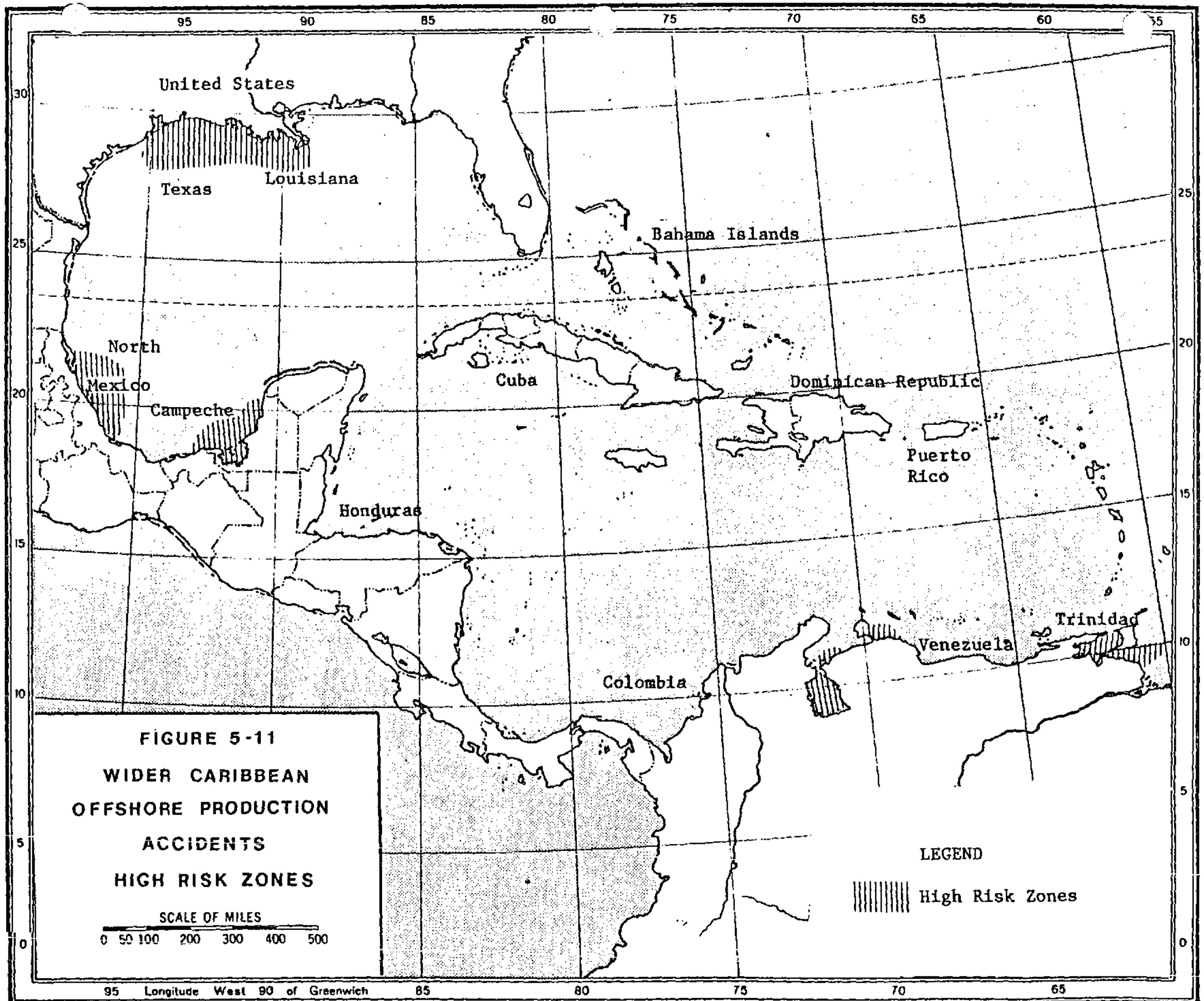
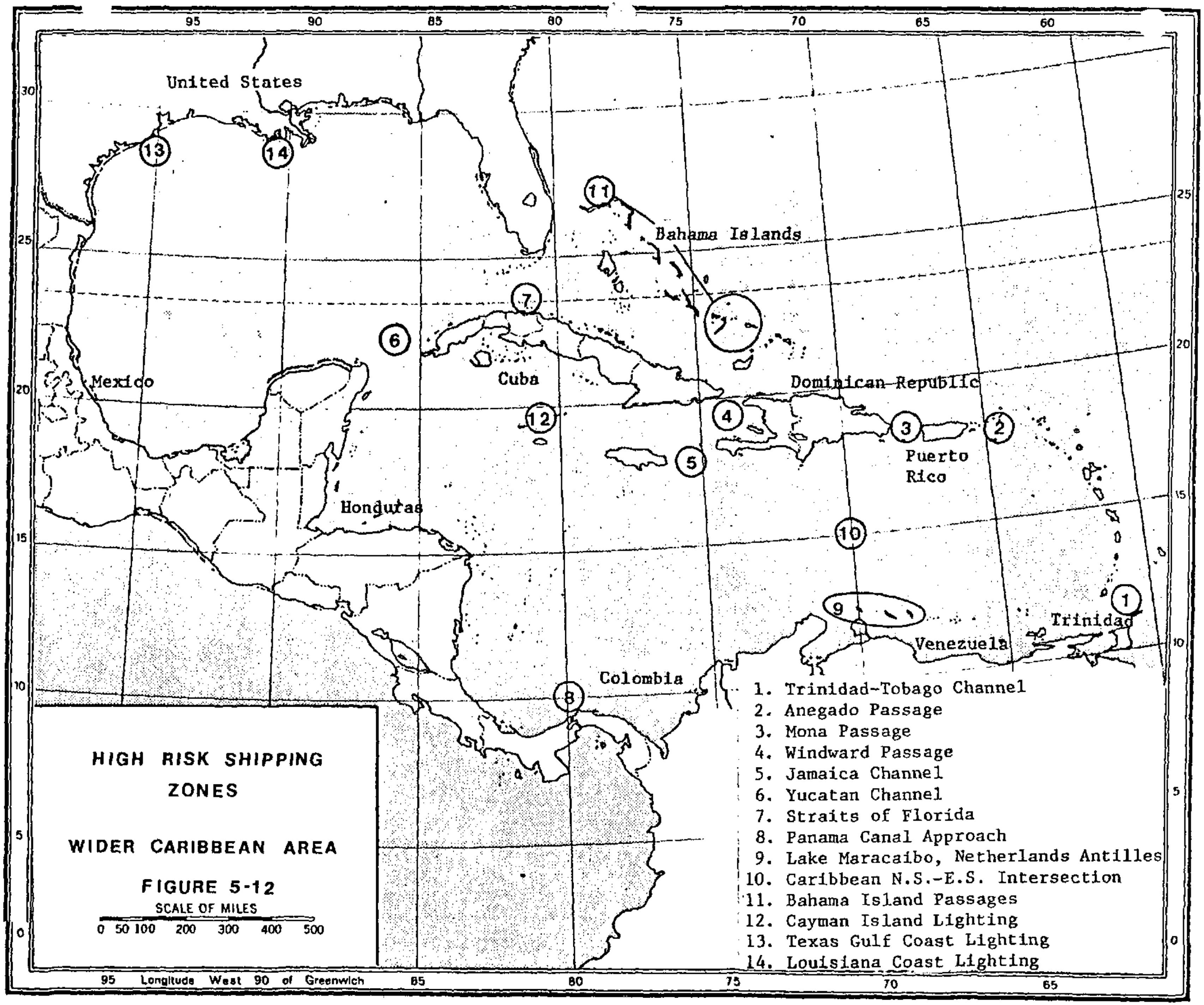


FIGURE 5-11
WIDER CARIBBEAN
OFFSHORE PRODUCTION
ACCIDENTS
HIGH RISK ZONES



HIGH RISK SHIPPING ZONES

WIDER CARIBBEAN AREA

FIGURE 5-12

1. Trinidad-Tobago Channel
2. Anegado Passage
3. Mona Passage
4. Windward Passage
5. Jamaica Channel
6. Yucatan Channel
7. Straits of Florida
8. Panama Canal Approach
9. Lake Maracaibo, Netherlands Antilles
10. Caribbean N.S.-E.S. Intersection
11. Bahama Island Passages
12. Cayman Island Lighting
13. Texas Gulf Coast Lighting
14. Louisiana Coast Lighting

areas likely to be impacted include the Caribbean coastline of Panama, Honduras, Nicaragua, Costa Rica, Mexico, Cuba, Hispaniola, Puerto Rico, the Virgin Isles, Jamaica, Cayman Islands, and the Bahamas.

Port Approach High Risk Zones

Figure 5-13 shows the various ports of the wider Caribbean area. The risk of tanker related accidents is a function of the level of tanker traffic, the level of other ship traffic and the navigational safety of the approach zone.

Zones of highest risk, in the opinion of the authors, are highlighted in Figure 5-13 . For each of these zones the likely zone of oil impact in the event of a spill is shown in Table 5-3.

Tank Washing, Oily Ballast Discharge High Risk Zones

The major risk zones for tank washing and oily ballast discharges are outlined in Table 5-3. The zones for these areas are shown in Figure 5-3. Other risk zones may exist, but the zones identified in Figure 5-3 represent the most significant areas based on information provided in Section 4.

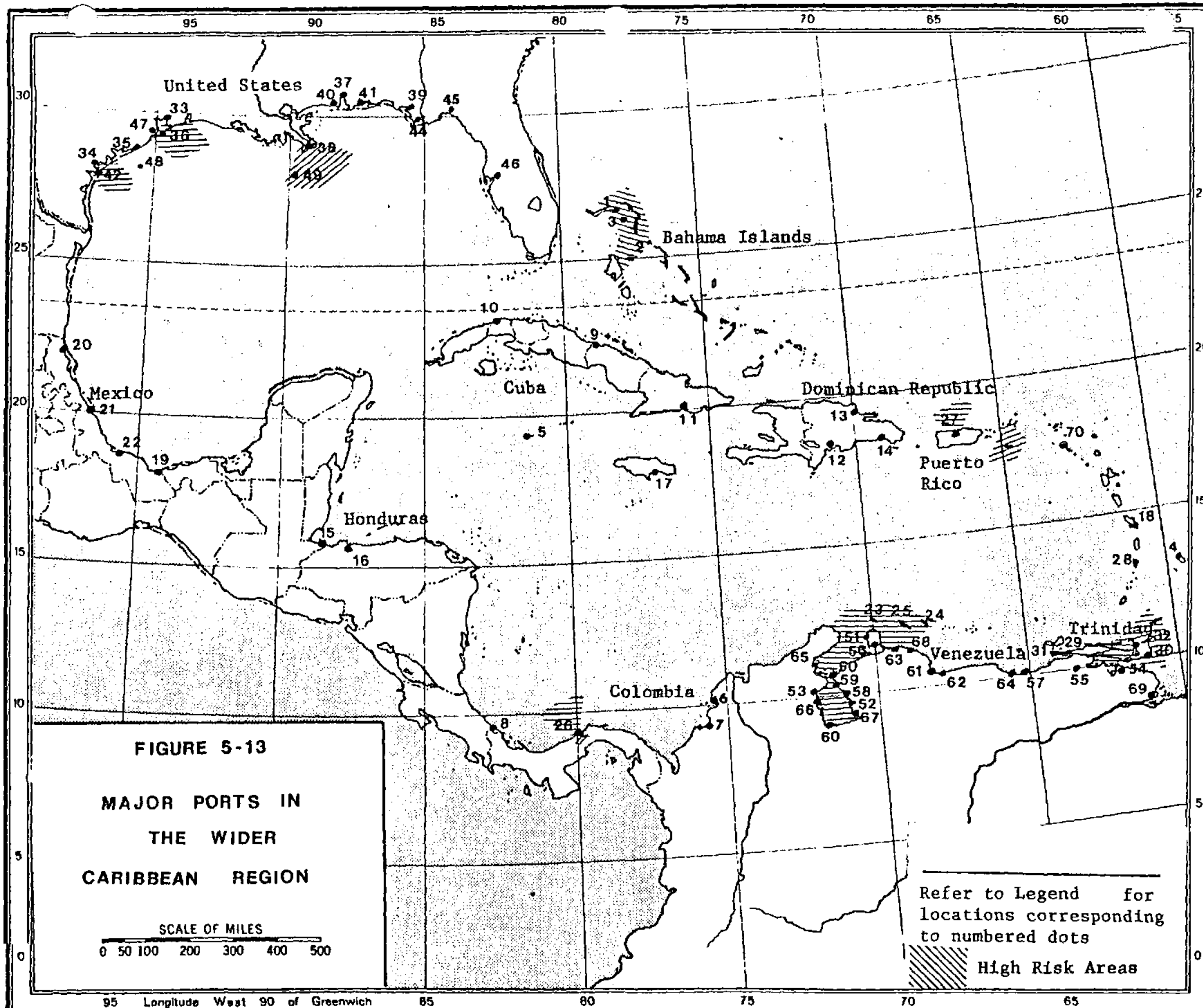


FIGURE 5-13

MAJOR PORTS IN THE WIDER CARIBBEAN REGION

LEGEND to FIGURE 5-13

Bahamas

Freeport (1)
Nassau (2)
South Riding Point (3)

Barbados (4)

Bridgetown
Cayman Islands (5)

Colombia
Cartagena (6)
Covenas (7)

Costa Rica
Limon (8)

Cuba
Cabaiguan (9)
Havana (10)
Santiago de Cuba (11)

Dominican Republic
Bonao (12)
Nigua (13)
Santo Domingo (14)

Guatemala
San Jose (15)

Honduras
Puerto Cortez (16)

Jamaica
Kingston (17)

Martinique
Fort de France (18)

Mexico
Coalzacoalas (19)
Tampico (20)
Tuxpan (21)
Veracruz (22)

Netherlands Antilles
Aruba (23)
Bonaire (24)
Curacao (25)

Panama
Colon (26)

Puerto Rico (27)
Guayanita
Los Mareas
Port Yacuboa
San Juan

St. Lucia (28)

Trinidad & Tobago
Brighton (29)
Galeota Point (30)
Point Fortin (31)
Point a Pierre (32)

United States
Baytown, Texas (33)
Corpus Christi, Texas (34)
Freeport, Texas (35)
Galveston, Texas (36)

United States (continued)
Mobile, Alabama (37)
New Orleans, Louisiana (38)
Panama City, Florida (39)
Pascagoula, Mississippi (40)
Pensacola, Florida (41)
Port Aransas, Texas (42)
Port Arthur, Texas (43)
Port St. Joe, Florida (44)
Saint Marks, Florida (45)
Tamps, Florida (46)
Texas City, Texas (47)
Texas Offshore Lightering (48)
Louisiana Offshore Lightering (49)

Venezuela
Altagracia (50)
Amuay (51)
Bachaquero (52)
Bajo Grande (53)
Capure (54)
Carpito (55)
El Cardon (56)
Guanta (57)
Lagunillas (58)
La Salina (59)
La Solita (60)
Moron (61)
Puerto Cabello (62)
Puerto Cumarebo (63)
Puerto La Cruz (64)
Puerto Miranda (65)
Punta de Palamas (66)
San Lorenzo (67)
Tucupido (68)
Tucupita (69)

Virgin Islands-St. Croix (70)

Tourism in the Wider Caribbean Region

The Caribbean region has experienced a substantial increase in Tourism during the last decade and a half. Such data as was available has been compiled and is presented in Table 5-4. Tourism is particularly important for the Insular Caribbean, many of which have virtually no other source of foreign exchange with which to pay for their imports of capital equipment for development projects. This is amply demonstrated in Table 5-4 by the number of tourist arrival per year per hundred of population; the figure for all of the smaller islands being above twenty and in several cases above fifty. Indeed Antigua and the British Virgin Islands which have virtually no other source of foreign exchange, have the highest tourist penetration rates of 104 and 407 respectively. Thus, insofar as tourism may be seen to be desirable, it is very susceptible to the effects of marine pollution and its attendent effects on the beaches.

The impact of oil on tourism can be severe, to some extent crippling areas where tourism is their chief source of income. Unsightly oiled beaches and seawalls may detract from attracting tourists. In addition, aquatic living resources, such as fish and shellfish that are damaged may also detract from tourism.

TABLE 5-4

TOURIST ARRIVAL, GROWTH RATE AND PENETRATION
IN THE WIDER CARIBBEAN REGION

Country	Year	Arrivals (Thousands)	Percentage Change	Annual Average Growth Rate (%)	Penetration Tourists/ 100/pop^n (Last quoted year)
I - Mainland					
Belize	1975	37.0[1]	-	NA	26
Colombia	1961	54.3[4]			
	1975	443.3	716.4	22.5[4] (1971-71)	1.5
Costa Rica	1961	46.5[4]			
	1975	297.2	539.1	18.2[4] (1971-74)	15.0
Guatemala	1961	95.9[4]			
	1975	454.4	373.8	20.0[4] (1971-74)	9.0
Guyana	-	NA	NA	NA	NA
Honduras	1961	31.6[4]			
	1974	412.3[4]	1205	20.0[4] (1971-74)	13.5
Mexico	1961	940.5			
	1975	3217.9	242.1	10.2[4] (1971-74)	5.0
Nicaragua	1961	40.7[4]			
	1974	164.8[4]	304.9	4.3[4] (1971-74)	8.0
Panama	1961	43.7[4]			
	1975	278.7	537.8	10.2[4] (1971-74)	17.0
Surinam	-	NA	NA	NA	NA
Venezuela	1965	29.6			
	1974	425.9	1339	43.5[4] (1971-74)	3.5

Sources:

1 ECLA/CARIB 77/5 - Economic Activity (1976) in Caribbean countries.

2 Kastarlak, B.I. - for UNDP Physical Planning Project Assistance in Physical Planning - "Regional Aspects of Tourism Development in Eastern Caribbean" (July 1976).

3 Shankland Cox Partnership for World Bank - "Tourism Supply in the Caribbean Region".

4 CEPAL RLA/71/414 - "Promocíon de Tourismo en América Latina y el Caribe - Conclusiones y Recommendaciones del Proyecto", Santiago, Chile, Feb. 1976.

TABLE 5-4
(continued)

Country	Year	Arrivals (Thousands)	Percentage Change	Annual Average Growth Rate (%)	Penetration Tourists/ 100/pop^{n} (Last quoted year)
II - Insular					
Antigua	1965	48.6[3]			
	1973	72.8[2]	49.8	6.5[3] (1968-72)	104.0
Barbados	1965	50.6			
	1975	222.0[1]	338.7	15.0[3] (1968-72)	91.0
Cuba	-	NA	NA	NA	NA
Dominica	1965	5.4[3]			
	1973	15.5[2]	187.0	11.0[3] (1968-72)	21.0
Dominican Republic	1965	43.9			
	1975	232.9	430.5	22.5[4] (1971-74)	5.0
Grenada	1965	13.9[3]			
	1975	21.1	51.8	13.0[3] (1968-72)	22.0
Guadeloupe	1969	18.8[3]			
	1972	28.0[3]	48.9	NA	79.0
Haiti	1965	46.8			
	1974	47.6	1.7	31.0[3] (1968-72)	1.0
Jamaica	1965	80.9			
	1975	395.8	389.2	12.0[3] (1968-72)	19.5
Martinique	1965	15.4[3]			
	1972	55.0[3]	257.1	27.5[3] (1968-72)	15.0
Netherland Antilles	1965	73.5[3]			
	1970	268.4[3]	265.2	15.0[3] (1968-72)	111.0
Puerto Rico	1965	925.9			
	1975	1339.1	44.6	6.0[3] (1968-72)	43.0
St.Kitts-Nevis-Anguilla	1968	9.8[3]			
	1973	14.8[2]	51.0	13.5[3] (1968-72)	22.0
St. Lucia	1965	12.9[3]			
	1975	51.8	301.6	17.0[3] (1968-72)	48.0
St. Vincent	1968	12.4[3]			
	1974	20.8[2]	67.7	8.0[3] (1968-72)	22.0
Trinidad & Tobago	1965	59.2			
	1975	132.6	124.0	6.0[3] (1968-72)	12.4
Virgin Is(Br)	1968	22.8[3]			
	1972	44.8[3]	96.5	18.5[3] (1968-72)	407.0
Virgin Is(US)	-	NA	NA	NA	NA

SECTION 6

STATUS OF OIL POLLUTION CONTROL IN THE WIDER CARIBBEAN

Programs of oil spill prevention and oil spill control in the wider Caribbean area, with but a few exceptions, are petroleum industry based programs.

In Appendix 1 of this report are listed the oil pollution control equipment, supply and manpower resources identified in the Caribbean Sea area in late 1976 as part of a study by the Clean Caribbean Cooperative. This information is part of country profiles from the standpoint of oil pollution control which present data on a wide variety of subjects that would be needed by groups from outside the individual country who would come to the country to carry out or participate in a cleanup program.

Appendix 2 provides detailed related information about local oil company facilities, oil industry related contractors and supplies which could be utilized during a cleanup response and also about government agencies which would have responsibility for carrying out or monitoring cleanup activities.

In Appendix 3 of this report information is presented on the oil spill control resources of the Clean Caribbean Cooperative supported by many of the oil companies using Caribbean waters to transport crude oil and products. Also presented is information on the oil spill control resources of the Clean Gulf Cooperative supported by most of the oil companies involved with oil exploration and production off the Gulf of Mexico coast of the United States.

Appendices 2 and 3 thus report most of the oil spill control resources available in the wider Caribbean area. Those items known not to be covered in the appendix included are the resources of Mexico and Cuba, the U.S. government and those of local harbors on the U.S. Gulf of Mexico coast.

Figure 6-1 is a summary of the numbers of booms, skimmers and drums of dispersant stored at major facilities in the wider Caribbean area. The wide difference in level of resources may be noted.

Figures 6-2 and 6-3 shows the geographical areas of interest of the Clean Caribbean Cooperative and the Clean Gulf Cooperative, respectively.

International Agreement Tool

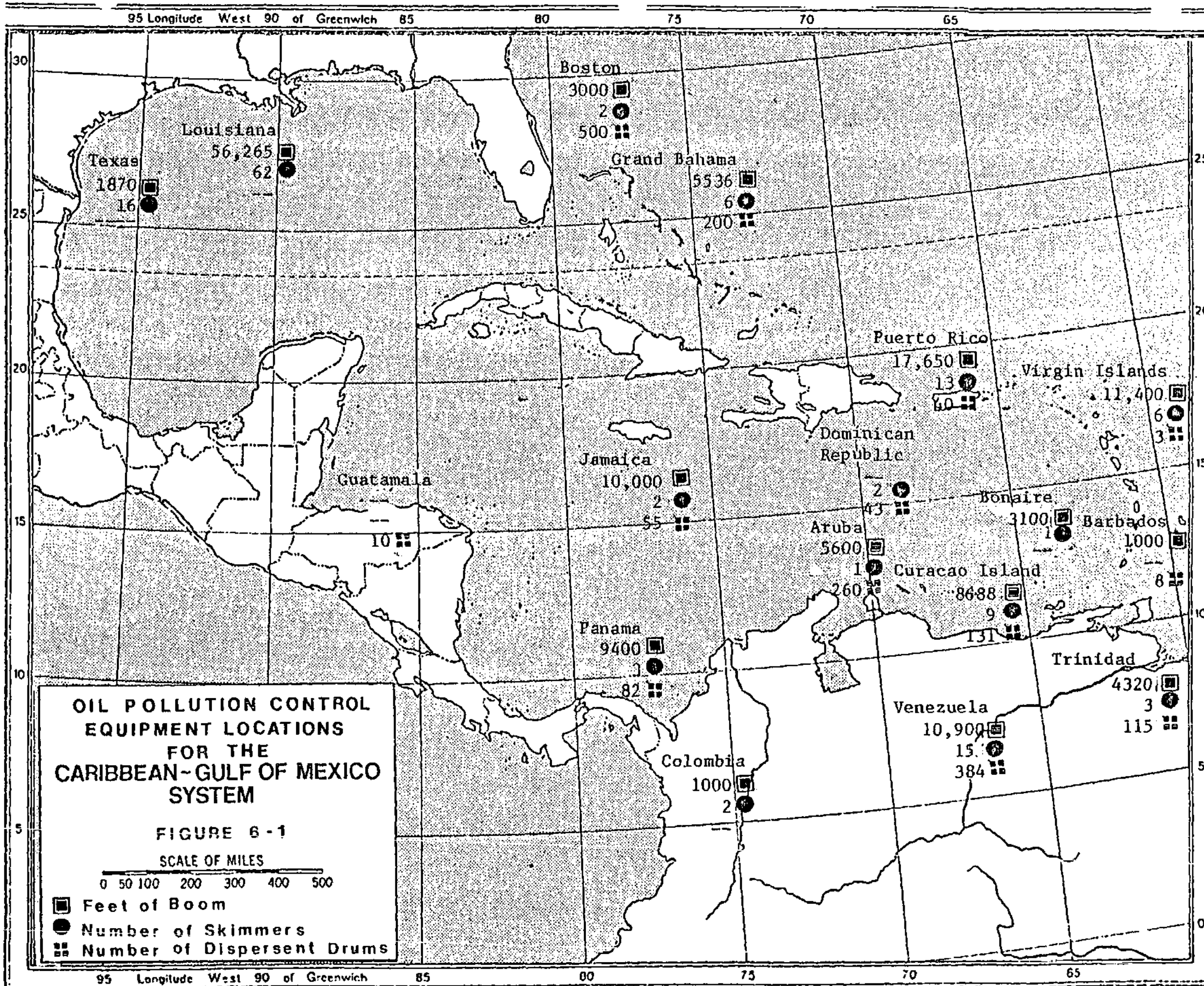
There have been developed, over the last 25 years, a series of international conventions which serve to help prevent pollution of the sea. These conventions will work only when ratified and enforced by nations, so as to either achieve compliance or to drive the bad actors from the seas.

These conventions are listed in Figure

The provision of the 1969 amendments to the 1954 convention are extremely important to the wider Caribbean area in that they require the equivalent of the land on tap tank and ballast water management system by limiting discharge to 1/15,000 of the cargo and 60 liters of oil discharge per mile. This discharge level is 1/75 of the amount of oil discharged by straight tank washing and discharge. For a 200,000 ton tanker this reduces the discharge of oil from 1000 tons or 7000 barrels per voyage to 26.7 tons or 93.3 barrels per voyage.

The 1973 Convention and the 1978 Protocol go even further in limiting discharge to 1/30,000 of the cargo. The Convention can roughly be divided into the three categories shown, namely:

Convention to limit chronic pollution discharges, such as ballast



OIL POLLUTION CONTROL EQUIPMENT LOCATIONS FOR THE CARIBBEAN-GULF OF MEXICO SYSTEM

FIGURE 6-1

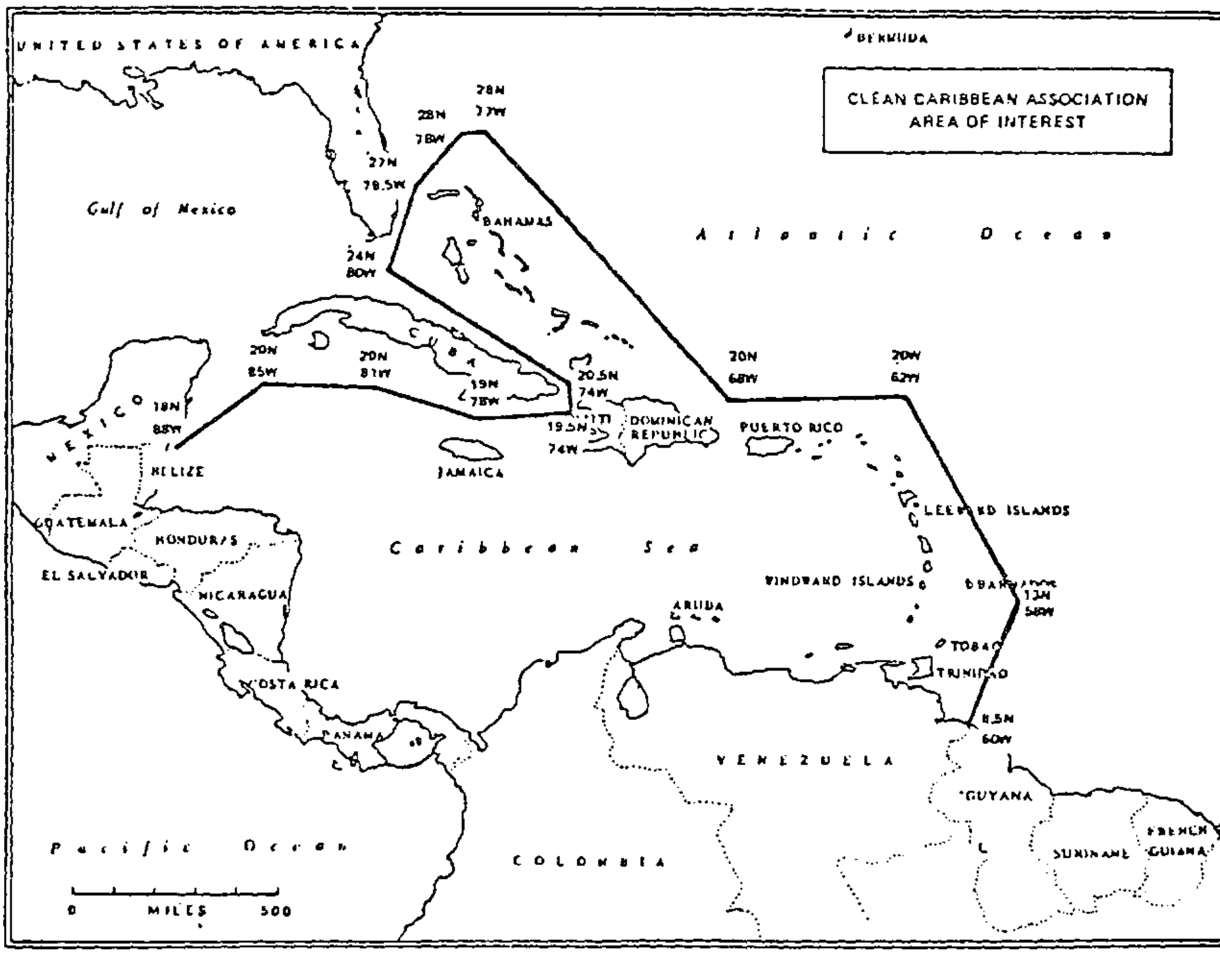
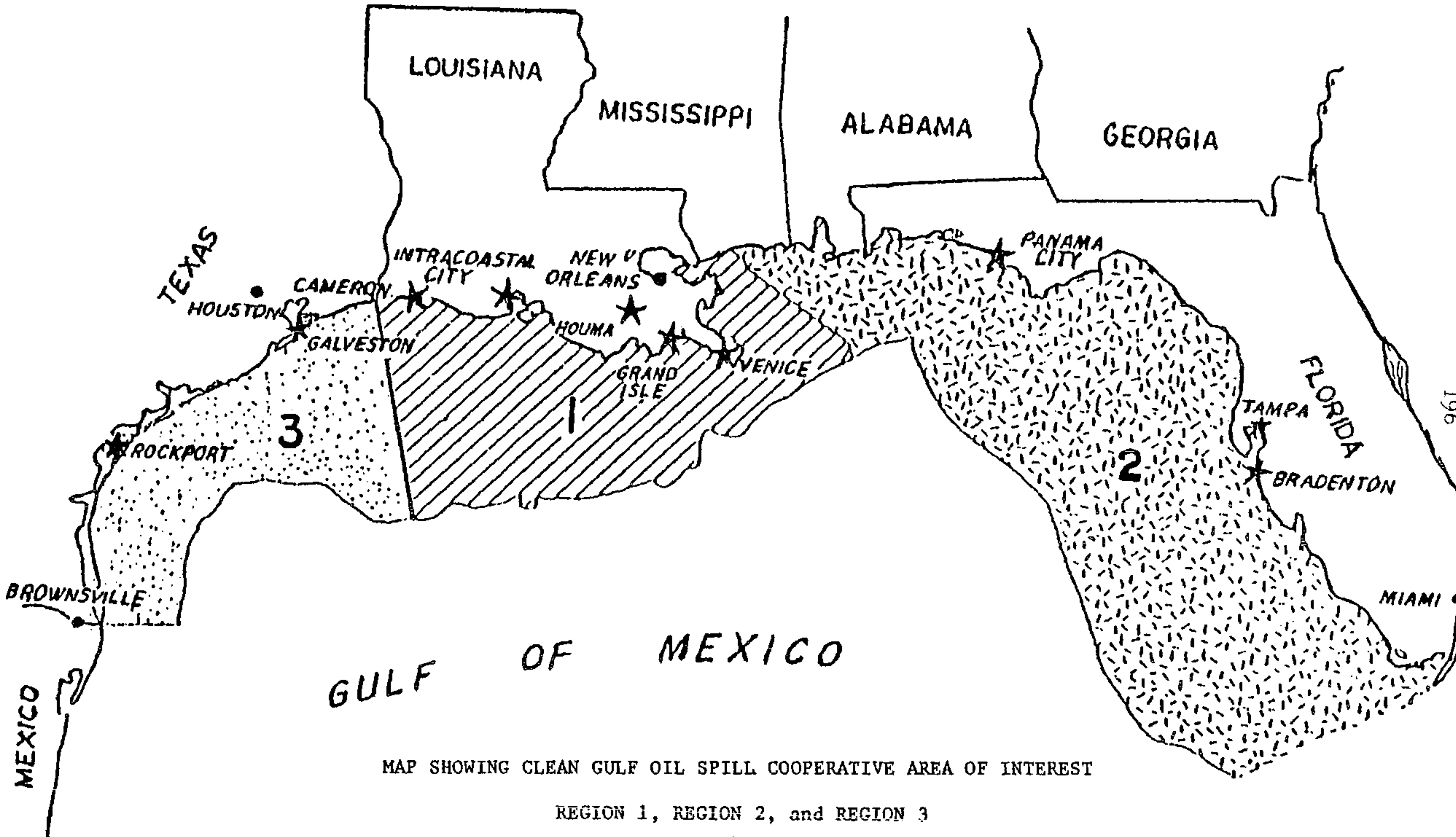


FIGURE 6-2

MAP SHOWING CLEAN CARIBBEAN OIL SPILL
COOPERATIVE AREA OF INTEREST



MAP SHOWING CLEAN GULF OIL SPILL COOPERATIVE AREA OF INTEREST

REGION 1, REGION 2, and REGION 3

FIGURE 6-3

water and tank washings from tanks.

Conventions to increase safety and reduce accidents at sea; and

Conventions to compensate for oil spill cleanup costs and damages.

It is emphasized that to obtain all of the benefits of these conventions a nation must have ratified the conventions.

Table 6-1 shows the provisions of the basic 1954 Convention and the 1973 Convention. The reader is referred to IMCO documents for the full text of the conventions.

The second group will only be dealt with briefly herein; these are the group of conventions aimed at preventing tanker accidents. Of particular interest are the pending 1978 Safety of Life at Sea (SOLAS) protocol which requires duplicate systems of key tanker components such as steering mechanisms and duplicate navigation systems.

The third group of conventions deal with the compensation for cleanup cost and pollution damage. Of particular interest to Caribbean countries is the planned phaseout of the voluntary insurance schemes (TOVALOP and CRISTAL) as the new CLC and Fund Conventions become established.

Tables 6-2, 6-3 and 6-4 provide further information on these important programs.

National Laws

National laws serve a valuable role in providing their officials with the authority to assure that proper pollution methods are taken and that programs to respond to cleanup are stablished. The following key items are options included in National Pollution Laws and Contingency Plans:

TABLE 6-1

Topic	1954 Convention (as amended in 1962)	1973 Convention
Applicability as regards carriage of oil	1. Seagoing tankers over 150 gross tons 2. Other seagoing ships over 500 gross tons	1. All tankers over 150 gross tons. 2. All other ships over 400 gross tons including novel craft and fixed and floating platforms.
Dispute settlement	Referred to International Court of Justice unless all parties agree to arbitration.	Compulsory arbitration by specially formed tribunals upon application of any party to dispute.
Amendment procedure	Effective only upon specific acceptance via IMCO assembly and contracting States.	Speedier method for annexes and appendices via IMCO Committee and tacit acceptance procedures.
Survey and certification	No comparable provision	1. Survey at 5-year intervals and at intermediate intervals. 2. Equipment must be approved by Administration (monitors, filters, separators, interface detectors). 3. Administration issues certificate attesting to compliance by its ships. Certificate shall be accepted except when there are clear grounds to believe the ship is not in compliance.
Definition of oil	1. Limited to crude, fuel, heavy diesel and lubricating oils 2. Does not include bilge slops and fuel and lube oil purification residues.	Includes all petroleum oils except petrochemicals (which are regulated by annex II).
Discharge criteria in prohibited zones (this term does not appear in the 1973 Convention which uses a distance from land criterion).	1. Prohibits discharges by all ships in concentrations in excess of 100 parts per million within the prohibited zones. 2. Prohibited zone generally 50 miles or greater from nearest land for tankers. Prohibited zone applies to other ships unless proceeding to a port not provided with adequate reception facilities.	1. Prohibits discharges which leave visible traces unless it can be established by installed instruments that the concentration discharged was less than 15 parts per million. 2. For tanker cargo slops, discharge is prohibited within 50 miles from nearest land. For other ships slops, and other tanker slops, discharge is prohibited within 12 miles from the nearest land.
Discharge criteria outside of the prohibited zones.	No restriction on discharges from a ship less than 20,000 gross tons. Vessels over 20,000 gross tons are limited to discharges whose concentrations are 100 parts per million or less, unless when in the opinion of the master, circumstances make it unreasonable or impractical to retain the higher concentrated slops on board.	1. Tankers must meet all the following conditions: a. Ship is proceeding enroute. b. Discharge is limited to 60 liters per mile instantaneous rate. c. Total quantity discharged is limited to 1/15,000 of cargo last carried for existing tankers and 1/30,000 of cargo last carried for new tankers. d. Tanker bilges, except pump rooms, shall be treated same as other ships. 2. Other ships must meet all of the following conditions: a. Ship is proceeding enroute. b. Oil content of the effluent must not exceed 100 parts per million.
Enforcement mechanism	No comparable provision	Requires that the monitoring and control system be in operation and a permanent record made anytime oily effluent is being discharged, except for clean or segregated ballast.
Construction and equipment requirements to control operational discharges of oily mixtures.	No comparable provision	1. Segregated ballast is mandatory for new tankers of 70,000 deadweight tons and greater, and is optional for tankers of less than 70,000 deadweight tons. Note that "new" tankers are defined by calendar dates and are therefore not dependent upon entry into force of this Convention. 2. Retention of oil on board (LOT) is mandatory for all tankers. 3. Mandatory installation of effluent monitor and control system, provision of slop tanks, and provision of oil/water interface detectors. Effluent must comply with discharge criteria or be transferred to reception facility. 4. Other ships require sludge tank installations, oil water separator and/or filters dependent upon ship size.
Reception facilities	Provision to promote according to need of ships using ports.	Expanded provision to undertake to insure availability and adequacy at oil loading ports, repair ports and at other ports according to the needs of ships.
Oil record book	Establishes basic requirement to provide oil record book and requires entries for specific operations.	Expands requirements to provide entries for more specific operations and in greater detail to aid in enforcement.
Construction requirements to limit the amount of oil discharge in case of accidents.	No comparable provision	1. Establishes damage assumptions and methods of calculation of the amount of hypothetical oil outflow for tankers. 2. Establishes tank arrangement and size limitations for the cargo tanks of tankers.. 3. Establishes subdivision and damage stability criteria to be applied to tankers to increase survivability in the event of accident.
Additional annexes for substances other than oil. Annex II is mandatory and annexes III, IV and V may be adopted at the motion of contracting States.	No comparable provision	1. Annex II details mandatory requirements for construction of chemical tankers and discharge criteria for liquid noxious substances in bulk. 2. Annex III contains regulations for the prevention of pollution by harmful substances carried at sea in packaged form, or in freight containers, portable tanks of road and rail tank cars. 3. Annex IV contains regulations for the prevention of pollution by sewage from ships. 4. Annex V contains regulations for the prevention of pollution by garbage from ships.

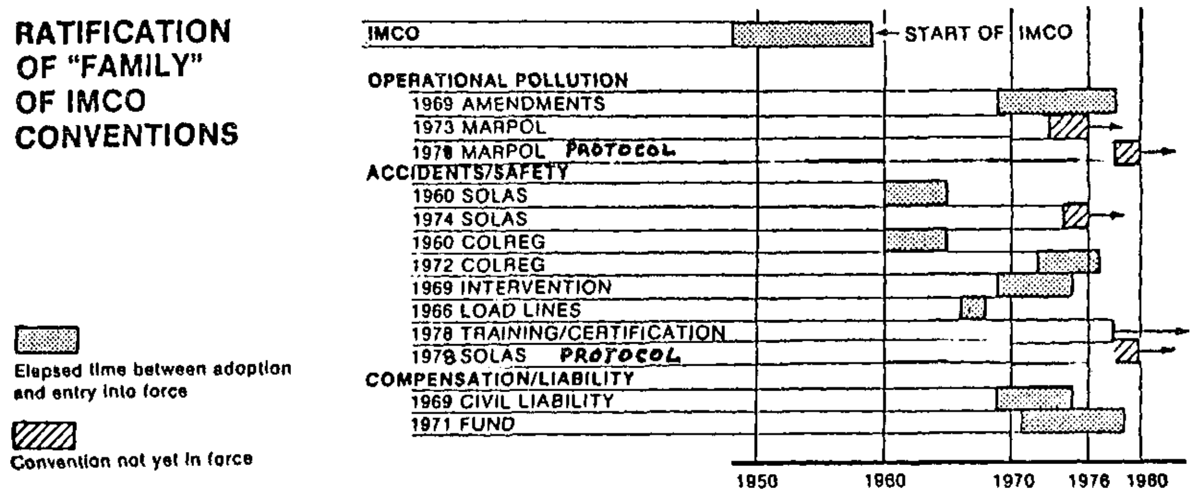
TABLE 6-2

	Civil Liability Convention	TOVALOP
PURPOSE	• Establishes uniform worldwide limit on liability for oil pollution damage and cleanup costs.	• Assure reimbursement of national governments for actions taken to avoid or mitigate damage from oil pollution, and encourage tanker owners to cleanup on their own account.
STATUS	• International treaty—In force since 6/19/75 (25 nations as of 7/30/76).	• Agreement among tanker owners—in operation since 1969.
SCOPE	• Seagoing vessels carrying oil in bulk as cargo. • Covers pollution damage to contracting nations' territory and seas, although spill can have originated elsewhere.	• 95% of free-world tanker tonnage (99% of those operating). • Seagoing tank vessels, including barges.
OILS	• Persistent oils (cargo or bunkers) if cargo being carried at time of spill (does not cover vessels in ballast).	• Persistent oils (cargo or tankers) or both loaded and ballast vessels.
DAMAGES	• Loss or damage by oil contamination, including cleanup costs. • Costs of preventive measures. • Further loss caused by preventive measures.	• Government oil removal costs (coastlines). • Tank vessel owners' cleanup costs. • Government or tank vessel owners' measures to avoid serious threat of pollution.
LIABILITY LIMITS	• $160/convention ton–not to exceed $16.8 million per incident.	• $1 /gross ton. Maximum $1 million per incident per tank vessel.
DEFENSES	• War, hostilities. • Exceptional natural phenomenon (Act of God). • Act with damage intent by third party. • Negligence or wrongdoing by any government (mis-maintenance of lights/navigational aids, etc.).	• Proof of no fault on part of vessel.
ADMINISTRATION	• Government agencies of contracting nations.	• International Tanker Owners Pollution Federation Limited.
FINANCIAL RESPONSIBILITY	• Vessel must be certified by a contracting nation as having sufficient financial coverage for convention liability.	• Must be established through P&I club, insurance company or ITIA (a specially formed company providing TOVALOP coverage).
CLAIMS PROCEDURE	• Actions brought in courts of contracting nations. Court determines apportionment and distribution of award.	• Claim registered with tank vessel owner who passes it on to insurer. • If claim disputed, arbitrated by International Chamber of Commerce.

TABLE 6-3

	Fund Convention	CRISTAL
PURPOSE	• Supplements Civil Liability Convention funds to assure compensation to parties suffering pollution damage or loss. Also would reimburse tanker owners for portion of their liability under the Civil Liability Convention.	• Increases the compensation available to persons sustaining pollution damage, supplementing TOVALOP or the Civil Liability Convention. Also reimburses shipowners for portion of "excess" cleanup costs.
STATUS	• International treaty; pending sufficient ratifications.	• Agreement among cargo owners, in effect since 1971. • Originally intended as interim substitute for Fund Convention.
SCOPE	• Contracting nation's territory and territorial seas, although spill can have originated elsewhere. • Vessels of nations which are party to the Civil Liability Convention.	• Any seagoing vessel or craft carrying bulk oil cargo (estimated to cover 90% of crude & fuel oil shipped by sea). • Seas, waters entered by seagoing vessels.
OILS	• Persistent hydrocarbon mineral oils.	• Persistent oils (cargo or bunkers).
CONDITIONS	• Contracting states must be party to the Civil Liability Convention. • Flag state must be party to the Civil Liability Convention in order for shipowner to receive compensation.	• Oil owned or "deemed" owned by party to CRISTAL • Tanker involved enrolled in TOVALOP, or Civil Liability Convention applicable to incident. • Circumstances such that Civil Liability Convention imposes liability on tanker owner.
DAMAGES	• Pollution damage to persons not adequately compensated under the Civil Liability Convention because of: —no Civil Liability Convention liability —financial incapability of vessel owner —damages exceed Civil Liability Convention liability	• Vessel owner's cleanup costs in excess of deductions (see below). • Pollution damages in excess of deductions.
FUND SIZE	• $36 million (can be increased to $72 million).	• $36 million guaranteed ($5 million actually being held).
METHOD OF FUNDING	• Contributions by cargo owners of participating nations proportional to volumes of oil received by participating nations.	• Contributions of cargo owners, proportional to volumes of oil transported by sea.
FUND LIABILITY	• Maximum $36 million, aggregate with Civil Liability Convention compensation. • Can be increased to $72 million by agreement of Assembly of Fund. • Compensates owner for Civil Liability Convention liability over $120/ton or $10 million, whichever is less, but not in excess of $160/ton or $16.8 million, whichever is less.	• Owner's cleanup costs less TOVALOP coverage. • Pollution damage to maximum of $36 million, less deductions for: —owner's cleanup costs in excess of $125/grt or $10 million, whichever is less, but not more than $36 million. —Liability to governments. —Any other liability of tanker owner or anyone else to the claimant as a result of a spill.
DEFENSES OF FUND	• War, hostilities. • No proof of ship-source spillage. • Intentional or negligent act of claimant.	• War, hostilities. • Third party act. • Government negligence.
ADMINISTRATION	• Fund Convention Secretariat, Executive Committee, and Assembly (latter comprising representatives of all contracting nations).	• Oil Companies Institute for Marine Pollution Compensation Ltd./Directors.
CLAIMS PROCEDURE	• Brought against the Fund Convention in court of contracting nation in which damage occurred.	• Direct application to the Institute.

TABLE 6-4



Intergovernmental Maritime Consultative Organization (IMCO) conventions. Conventions referred to are: MARPOL—International Convention for Prevention of Pollution from Ships; SOLAS—International Convention for Safety of Life at Sea; COLREG—International Regulations for Preventing Collisions at Sea; INTERVENTION—International Convention Relating to Intervention on the High Seas in Case of Oil Pollution Casualties; LOAD LINES—International Convention on Load Lines; TRAINING/CERTIFICATION—1978 Conference planned to develop Convention on Maritime Training; CIVIL LIABILITY—International Convention on Civil Liability from Oil Pollution Damage; and FUND—International Convention on Establishment of an International Fund for Compensation for Oil Pollution Damage.

Civil Liability and Fund Conventions

Recognizing the need for the legal machinery to deal with oil spills, in 1969 the Intergovernmental Maritime Consultative Organization (IMCO) sponsored the adoption of the International Convention on Civil Liability for Oil Pollution Damage. This Convention represents a significant step forward in developing legal remedies for persons or nations injured by oil spills. It also standardizes criteria of financial responsibility for pollution cleanup and damage liability within the international marine community. This Convention has been in force since June,1975; as of November 1, 1976, it had been ratified by 28 nations (or "contracting states").

The Civil Liability Convention covers pollution damage to a contracting state's territory or territorial seas resulting from a spill of persistent oil carried by seagoing vessels. The spill may have originated on the high seas, but only resulting damage within territorial waters is covered. Bunkers are also covered if the vessel was carrying oil cargo. The Convention places the primary responsibility for oil pollution damage on shipowners. Vessels covered by the Convention must have on board proof that they are covered by insurance sufficient to meet the requirements of the Convention.

Under the Convention, injured parties may collect up to $160 per ton of ship's tonnage*, with a maximum of $16.8 million per incident, for costs of loss or damage due to oil pollution, including cleanup costs. The Convention also provides for compensation of preventive measures, such as use of skimmers or protection booms.

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* Under the Convention, ship's tonnage is net tonnage plus tonnage of engine room space.

There are some circumstances under which a shipowner is not liable for the costs of cleanup, damage or loss due to oil pollution under this Convention. These include: 1) "acts of God" (lightning); 2) acts of war or hostilities; 3) negligence by governments (failure to maintain navigational aids); or 4) action of a third party claimant with intent to do damage (sabotage). These situations are called "defenses".

The injured party suffering damage or loss, or the party incurring cleanup costs, makes a claim against the tank owner. If the owner does not have a defense under the Convention, he may settle out of court with the claimants. Otherwise, the claim is heard in the court of the contracting state where the damage occurred; liabilities of the owner are determined and payment made by the owner's insurers. If a shipowner is able to use one of the defenses, or if costs exceed Civil Liability Convention limits, the injured party could then turn to the Fund Convention.

Fund Convention

Because there are limits to the compensation available to the damaged parties under the Civil Liability Convention, another Convention was adopted under IMCO sponsorship in 1971 to supplement the Civil Liability Convention. The International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage creates a fund financed by mandatory contributions from contracting states which receive oil shipped by sea. This Convention applies only to those situations and vessels already covered by the Civil Liability Convention.

The Fund Convention more than doubles the maximum amount of compensation available under the Civil Liability Convention - from $16.8 million to $36 million per incident (at 1975 rates). The upper limit of the Fund

Convention could be increased to $72 million if necessary by a decision of the governing body of the International Fund. Furthermore, a shipowner who is shown to be liable for costs over $120 per ton or $10 million, whichever is less, under the Civil Liability Convention will be able to apply to The Fund for reimbursement of the portion of his liability exceeding these figures, up to a maximum of $160 per ton or $16.8 million, whichever is less. Thus, the owner's insurer's would be relieved of part of their burden under the Civil Liability Convention.

Parties damaged by oil pollution which might not be able to obtain compensation under the Civil Liability Convention could sue the International Fund. This includes incidents in which: 1) a shipowner is not liable because he has a defense under the Civil Liability Convention; 2) damage exceeds the limitation of liability under the Civil Liability Convention; or 3) the shipowner and his guarantor are financially incapable of meeting their obligations under the Civil Liability Convention.

However, if an incident results from an act of war or hostilities, from negligence on the part of the injured party making the claim, or from intentional act of the claimant to do damage, the Fund generally would not be obligated to provide compensation.

TOVALOP and CRISTAL

Recognizing that it would take several years before the Civil Liability and Fund Conventions would come into force, the industry voluntarily developed two complementary insurance agreements which would provide compensation during the interim period. While the Conventions are agreements among nations, these are agreements among tanker owners and cargo owners respectively.

The first, TOVALOP (Tankers Owners Voluntary Agreement Concerning Liability for Oil Pollution), was adopted in 1969 and now covers 95 percent of the free world's oil tankers (99 percent of those actually operating). Tanker owners which are parties to TOVALOP are members of a Federation which administers the agreement.

Under TOVALOP, it is the tanker owner's responsibility to clean up a spill or to remove the threat of spill in any coastline area. The shipowner is reimbursed through his insurer up to $125 per grt of the tanker involved, or $10 million, whichever is less. If the shipowner does not respond promptly, and cleanup is undertaken by a national or local government, the shipowner will reimburse the government through his underwriters according to TOVALOP liability limits. The only defense against paying for third party cleanup recognized by TOVALOP is proof that the ship is not at fault. Negligence on the part of the tanker and its owner is presumed, and the owner has the burden of proving lack of negligence.

TOVALOP differs from the Civil Liability Convention in several details. TOVALOP includes coverage of tankers in ballast which the Civil Liability Convention does not. TOVALOP is limited to damage done to a nation's territorial seas. TOVALOP covers pure threat situations; the Civil Liability Convention does not. TOVALOP does not cover damages to third parties; the Civil Liability Convention does. The definition of "owner" under TOVALOP includes bareboat charterers, who are not covered under the Convention. Finally, the maximum amount of liability and defenses available to the shipowner differ, as described above.

CRISTAL (Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution) has been in effect since 1971 as a supplement to TOVALOP much as the Fund Convention is meant to supplement the Civil Liability Convention. Since the Civil Liability Convention has come into force, CRISTAL has also served to supplement this Convention since the Fund Convention is not yet in force. Thus, CRISTAL applies not only to tankers already enrolled in TOVALOP, but also to those subjects to the Civil Liability Convention, as long as the polluting incident meets Civil Liability Convention criteria and the cargo is owned by a party to CRISTAL. CRISTAL, in contrast to TOVALOP, is an agreement solely among cargo owners and is administered by the Oil Companies Institute for Marine Pollution Compensation, of which CRISTAL members are shareholders.

The Institute receives funds through contributions from the oil companies which are parties to CRISTAL. The Institute made an "initial call" upon its members in the amount of $5 million, or about $.0635 per barrel of crude or fuel oil received by its members by sea. Additional assessments are being made to cover major spills such as the Amoco-Cadiz.

To the extent compensation is not obtainable under the Civil Liability Convention, TOVALOP or national legislation, the Institute will reimburse the shipowner for costs incurred in cleanup of pollution, or in the removal of the threat of pollution, in excess of funds available under TOVALOP ($125 per grt or $10 million, whichever is less) up to a maximum of $30 million, on the theory that the owner should pay as much as possible.

For third party pollution damage, the Institute will pay a maximum of $30 million, less: the amount of the owner's cleanup costs, any liability of the owner under TOVALOP, and any liability of the owner or anyone else towards the claimant.

CRISTAL compensates only for pollution costs exceeding deductions or for excessive cleanup costs; it does not apply in cases where a shipowner is not liable under the Civil Liability Convention.

Authority

Policy and Responsibilty

Liability, enforcement, penalties

Prevention Activities

Planning and Response organization

Response Phases

Resources

Recovery of Costs

Although not entirely suited to other countries, the oil pollution laws (FWPCA) and oil spill contingency plan of the U.S.A. has undergone the test of time and can serve as a useful point of departure for the development of oil pollution control laws of other countries.

Copies of the appropriate parts of the U.S. Federal Water Pollution Control Act and the entire U.S. National Contingency Plan are included as Appendix 5 of this report.

An appropriate future activity for the Caribbean Sea countries would be the development of an appropriate "model law and plan" for this region.

SECTION 7

THE BACKGROUND SITUATION FOR FUTURE PLANS

OPTIONAL PATHWAYS FOR THE FUTURE

AND RECOMMENDATIONS

In previous sections of this report, we have looked at the background physical environmental system of the wider Caribbean area, spill potential from production, oil spill potential from existing tanker traffic and have looked at the environmental systems which can be impacted to various degrees by an oil spill. We have also predicted various high risk areas within the Caribbean and identified the most likely point of impact of spills from these risk areas. In the last section we presented summary infromation about specialized spill control equipment resources available within the wider Caribbean area and pointed out the more extensive information available in the various appendices of this report.

Let us now look at a few background conditions from which future planning should be directed.

1) It is to be expected that oil shipments within and through the wider Caribbean area will remain on the same order of magnitude as they now are for the foreseeable future.

2) Increased offshore oil development will evolve and be pushed into deeper waters.

3) There exists a modest oil spill response capability for dealing with port or terminal oil spills in some parts of the Gulf and the Clean Caribbean Cooperative maintains its dispersant capability at sea but these two resources are the major levels of response available at this time in the Caribbean.

4) Few of the governments in the wider Caribbean area maintain oil spill contingency plans capable of dealing with major spills nor do they currently have the specialized oil pollution control equipment supply resources or trained people to execute such a plan.

5) Only a handful of specialized oil pollution control laws exist within the wider Caribbean area or were identified within the wider Caribbean area.

6) The shift from the Tanker Owners' Voluntary Insurance Fund or TOVALOP to the Intergovernmental Civil Liability Convention may require ratifying governments to become more active in oil spill response and to insure their internal laws provide methods for recovering cleanup costs under the Civil Liability Convention in the event of an accident.

The countries of the Caribbean either individually or collectively can choose among several options in regard to oil pollution control.

1) The first is that each individual country can decide either to initiate or to carry out a program of oil pollution control or to stay out of the activity and let the industry of the area handle all the response. Getting into an area means that a major program may be established to develop the legal and physical resources to carry out a program, provide the trained cadre of people, to carry out extensive contingency planning and to carry out and develop spill response activities when spills occur.

2) The second option is for the nations to carry out their programs individually or to band together into a regional program to work together.

3) The third option is for the nations of the Caribbean to either develop a completely separate pollution control program apart from industry or they can try to develop a closely integrated oil pollution control program in partnership with industry.

4) They can either allow any tanker on the high seas to enter and discharge in the Caribbean area or they can develop a program to insure that only the tankers who follow clean, safe practices enter into the wider Caribbean area.

Problem Solution

The author has included 10 Problem Solution Analyses in this report. Each analysis states the problem, the group of countries faced with the problem, potential methods to prevent the problem, potential methods of dealing with the problem if it occurs and needed background information. These analyses are shown as Tables 7-1 and 7-10 .

To promote the execution of these programs a driving force is necessary. It is understood that an OAS team has been proposed to aid in the development of such an oil spill program. It is expected that this program will carry out the following type of plan:

A. Establish a core group to stimulate the development of an oil spill control program.

B. Monitor and report on the development of the oil pollution control program thus stimulated.

C. Develop model programs in areas such as:

   1) Prevention of Pollution
   2) Administrative Contingency Response Plan Development
   3) Site Specific Contingency Response Plan Development
   4) National Oil Pollution Control Laws

D. Serve as consultants to emerging national programs.

E. Promote regional cooperation.

F. Sponsor programs to upgrade national and local exposure to the problems and technical training in oil spill control.

Of particular interest in these programs are two major components. The first is the use of the existing or proposed IMCO Conventions (which were outline earlier) to achieve reduction of tanker accidents or routine pollution discharges from tankers.

The second is the need for effective contingency planning. IMCO is now publishing a major guide to contingency planning. The authors particularly point out their division of contingency planning into two components.

Administrative Contingency Plans and Site Specific Operational Contingency Plans

The Administrative Plans are usually made for high levels of government or for the head office or regional office of a major industry.

Since the major function of high government or industry is not oil pollution control, their interest in oil spill contingency planning is like other forms of contingency planning such as fire, riot, strikes, etc.

Thus, to some extent, the main purposes are:

1. To keep the overall administration in power.
2. To keep individual administrators out of jail and in their jobs.
3. To keep citizens or stockholders from becoming angry.

etc.

In other words the role of the contingency plan is to assure the government or industry organization can go about its main business of governing or making money with the minimum possible disruption.

Summary Suggestions

In view of the information presented in this report and the current status of pollution control in this area and the various options open to the countries, the following suggestions are made:

Prevention

1) The countries of the Caribbean should insure adequate spill prevention and control plans are developed for the potential oil spill sources within each country, such as refineries, loading docks, etc.

2) The countries of the Caribbean should proceed as rapidly as possible to ratify and enforce the appropriate international conventions which lead to the reduction of tank washings discharges into the Atlantic and the Caribbean and which call for proper equipment and safe operating practices on the part of tankers.

3) The Caribbean governments initiate a program to monitor worldwide tanker washing discharges including:

   a) the identification of tankers which do not use load-on-top, crude oil washing, segregated ballast tanks or dedicated clean ballast tank methods or which do not discharge tank washings into shore receiving stations.

   b) the evaluation of the rate of change in tank washings to the wider Caribbean, Gulf of Mexico and Atlantic Ocean.

Control of Major Accidental Spills

4) A program of mutual assistance be developed within the Caribbean that involves governmental resources as well as the industrial resources.

5) The governments of the Caribbean particularly investigate the capabilities of the response the major spills which could be carried

out by those companies not participating in the Clean Caribbean Cooperative.

6) The governments of the Caribbean develop their response capabilities in areas that will be complimentary to, rather than duplicative of existing industry programs. Of particular importance would be programs utilizing public resources for beach cleanup, programs to protect particularly valuable environmental or economic resources and programs to assure that both site-specific and general contingency plans are available.

7) The governments of the Caribbean carefully evaluate the industrial response available for any refinery or port facility within their jurisdiction and that if deficiencies are found that adequate response capability be required as a condition of doing business in the country.

8) That the problem of compensation for spills-cleanup costs and damages, where the spill impacts several countries, be addressed.

Control of Chronic Oil Spills

9) The governments of the Caribbean area carefully measure the chronic spill levels from production facilities, refineries, etc., be carried out and that where spill discharges do not conform with acceptable worldwide standards for the industries, suitable remedies be sought.

10) An appropriate data base be established for the Caribbean area to record small, as well as large, spills so that the predictions made in this report about spill rates can be updated based on real data for the Caribbean rather than on the U.S. industrial experience.

These administrative contingency plans serve, however, a valuable purpose in that they:

1) Assign responsibility (and hopefully authority).

2) Provide financial resources.

3) Designate institutional manpower and equipment resources.

4) Designate policy making process to be followed.

5) Establish national programs for prevention of the problem.

Thus, a good administrative contingency plan is essential.

Often, however, in both government and industry, the planning stops at this point and does not proceed to the second stage of contingency planning - the Site Specific Operational Contingency Plan.

TABLE 7-1

Wider Caribbean Oil Pollution Problem Solution Analysis # 1

Statement of the Problem:

The threat of major oil spills resulting from collision, grounding, explosion or structural failure.

Wider Caribbean Countries Experiencing Problem:

All to a varying degree, depending on the proximity to shipping lanes and prevailing wind currents.

Potential Preventive Solution: (Local, National, Regional, International)

1. International: Support International IMCO Conventions for Vessel Safety, protective design and pollution compensation.
2. Regional or National: Establish traffic lanes and/or establish survey lane and tracking systems and communication systems in high risk areas.
3. National: Prohibit entry into national waters of ships not conforming to acceptable standards.

Potential Remedial Solution: (Local, National, Regional, International)

1. Regional: Develop a regional plan of mutual assistance to share resources of men, equipment and supplies in the event of a major spill threat or impact.

2. National and Local: Assure that appropriate administrative and site specific contingency plans are developed to deal with spills of various sizes.

What Needs to Be Known to Initiate Activity:

Levels of effort required to deal with spills of various sizes.

TABLE 7-2

Wider Caribbean Oil Pollution Problem Solution Analysis # 2

Statement of the Problem:

Threat of oil spills of fuels and lubricants from collisions, grounding, and sinking of ships other than cargo carrier tankers which are not covered by IMCO Oil Pollution Conventions, TOVALOP or other spill programs.

Wider Caribbean Countries Experiencing Problem:

All to a varying degree, depending on proximity to non-tanker shipping routes.

Potential Preventive Solution: (Local, National, Regional, International)

1. International: Seek international Conventions and/or insurance programs for ships other than those carrying oil as cargo.
2. Regional and National: Establish a program under national law to prohibit unsafe ships in local ports, to require appropriate insurance for ships other cargo carrying tankers and to establish responsibility for cleanup.

Potential Remedial Solution: (Local, National, Regional, International)

1. Local and National: Develop an effective oil spill contingency planning on both the administrative and site specific levels.

2. National: Develop appropriate contingency funds to deal with such spills in the absence of effective intermediate programs.

What Needs to Be Known to Initiate Activity:

TABLE 7-3

Wider Caribbean Oil Pollution Problem Solution Analysis # 3

Statement of the Problem:

Tar spots and tar balls carried to the wider Caribbean beaches as a result of tank washing in the Atlantic.

Wider Caribbean Countries Experiencing Problem:

Windward and Leeward Islands

All others but to a lesser degree.

Potential Preventive Solution: (Local, National, Regional, International)

1. International: Ratify IMCO Conventions which limit or eliminate routine oil discharges at sea.

Potential Remedial Solution: (Local, National, Regional, International)

1. Local: Beach cleaning of oil and oil/sand pellets.

What Needs to Be Known to Initiate Activity:

Obtain up to date information on the tank cleaning and ballast water management on the tankers involved in the Arabian Gulf, West African and North African to Europe and Eastern U.S.A. routes.

TABLE 7-4

Wider Caribbean Oil Pollution Problem Solution Analysis # 4

Statement of the Problem:

Tar spots and tar balls deposited on the shores of the wider Caribbean as a result of tank washings discharged into the Caribbean Sea and the Gulf of Mexico.

Wider Caribbean Countries Experiencing Problem:

U.S.A. (Texas), Mexico, others to be determined.

Potential Preventive Solution: (Local, National, Regional, International)

1. International: Ratify IMCO Conventions which limit or eliminate routine oil discharge at sea.
2. National: Forbid entry of tankers not using techniques called for under IMCO 1969 amendments and/or 1973 Conventions.
3. National: Require submission of binding tank washing plan before allowing tankers to depart a harbor.
4. National and International: Develop a receiving station for tank washings, bilge water and dirty ballast.

Potential Remedial Solution: (Local, National, Regional, International)

1. Local: Beach cleaning of oil or oil sand pellets.

What Needs to Be Known to Initiate Activity:

TABLE 7-5

Wider Caribbean Oil Pollution Problem Solution Analysis #5

Statement of the Problem:

Potential impact of oil spilled in a neighboring country from a collision, grounding, explosion, loading or lightering accident, or other form of oil discharge such as production, refining, etc.

Wider Caribbean Countries Experiencing Problem:

All to a varying degree of risk depending on proximity to other countries, level of oil related activity in adjacent countries, prevailing wind and prevailing currents.

Potential Preventive Solution: (Local, National, Regional, International)

1. Local and National: Establishment of national programs of spill prevention and control planning and/or associated program of facility inspection within the wider Caribbean region.
2. Regional: Establish regional insurance program to pay response and damage costs for spills not covered under CLC, TOVALOP, Fund Convention or CRISTAL.
3. International: Support International IMCO Conventions for Pollution Compensation.

Potential Remedial Solution: (Local, National, Regional, International)

1. Regional: Develop a regional plan of mutual assistance to share resources of men, equipment and supplies in the event of a major spill threat or impact.
2. National and Local: Assure that appropriate administrative and site specific contingency plans are developed to deal with spills of various sizes.

What Needs to Be Known to Initiate Activity:

TABLE 7-6

Wider Caribbean Oil Pollution Problem Solution Analysis # 6

Statement of the Problem:

Potential local impact from loading and unloading accidents in harbors, at buoys, and lightering operations.

Wider Caribbean Countries Experiencing Problem:

All with varying risk depending on petroleum throughput of port facilities.

Potential Preventive Solution: (Local, National, Regional, International)

1. Local and National: Establish national program of spill prevention and control planning and associated program of facility inspection.
2. National: Require facilities in country to have appropriate insurance to pay cost of spill cleanup and damage.
3. National: Forbid entry to ship with substandard oil pollution prevention methods.

Potential Remedial Solution: (Local, National, Regional, International)

1. Local: Require preventive booming, facility design, etc. to contain spilled oil and prevent release into environment.

2. Local and National: Assure that appropriate administrative and site specific contingency plans are developed to deal with spills of various sizes.

What Needs to Be Known to Initiate Activity:

Inventory of loading facilities and current status of local prevention and spill contingency plan programs.

TABLE 7-7

Wider Caribbean Oil Pollution Problem Solution Analysis #7

Statement of the Problem:

Potential for major offshore production related spills from blowouts, platform explosions, pipeline failure, natural phenomena, sabotage, etc.

Wider Caribbean Countries Experiencing Problem:

Venezuela, Trinidad & Tobago, Mexico, U.S.A. (Louisiana and Texas), and all others to a varying degree of risk based on location and relative offshore production and prevailing winds and currents.

Potential Preventive Solution: (Local, National, Regional, International)

1. National: Assure that offshore operations are carried out with proper spill prevention technology including blowout prevention, storage, pipe line construction methods, etc.
2. Regional: Develop regional insurance program to insure payment of cleanup and damage costs in not only originating but also impacted countries.

Potential Remedial Solution: (Local, National, Regional, International)

1. Local and National: Assure that appopriate administrative and site specific contingency plans are developed to deal with spills of various sizes.
2. Regional: Develop a regional plan of mutual assistance to share resources of equipment, men, and supplies in the event of a major spill threat or impact.

What Needs to Be Known to Initiate Activity:

TABLE 7-8

Wider Caribbean Oil Pollution Problem Solution Analysis #8

Statement of the Problem:

Discharge of oil contaminated produced water, drilling mud, lubricating oil and deck drainage from offshore platforms.

Wider Caribbean Countries Experiencing Problem:

Venezuela, Trinidad & Tobago, Mexico and the U.S.A. (Texas and Louisiana)

Potential Preventive Solution: (Local, National, Regional, International)

1. National: Establish and enforce national standards for type of drilling muds allowed and require treatment levels on produced water and other discharges.

2. Local: Inspect local facilities to insure compliance.

Potential Remedial Solution: (Local, National, Regional, International)

Usually none feasible.

What Needs to Be Known to Initiate Activity:

1. Experience of discharges in given country.

2. Achievable discharge values with current technology.

TABLE 7-9

Wider Caribbean Oil Pollution Problem Solution Analysis # 9

Statement of the Problem:

Potential impact of refinery discharges on environment.

Wider Caribbean Countries Experiencing Problem:

All with refineries.

Potential Preventive Solution: (Local, National, Regional, International)

1. National: Establish and enforce national standards for oil spill prevention and effluent requirements for refinery discharges.
2. Local: Inspect local facilities to insure compliance.
3. National: Assure refinery effluents coupled with other pollution stress (i.e. domestic, industrial and agricultural wastes) do not overload the system.

Potential Remedial Solution: (Local, National, Regional, International)

Local: Retrofit of refinery waste treatment systems and other pollution prevention equipment.

National and Local : Assure that appropriate administrative and site specific contingency plans are developed to deal with spills of various sizes.

What Needs to Be Known to Initiate Activity:

Background waste loadings from other sources in impacted system.

TABLE 7-10

Wider Caribbean Oil Pollution Problem Solution Analysis #10

Statement of the Problem:

Threat of destruction of a valuable environmental system uniquely important to a nation such as protective barrier reef.

Wider Caribbean Countries Experiencing Problem:

Barbados, Tobago and other island nations with similar important systems.

Potential Preventive Solution: (Local, National, Regional, International)

1. International: Seek prohibition of shipping of cargos with the volume and toxicity to cause damage in zone from which contamination could occur. i.e. Exclude tankers and chemical cargo ships in a zone 100 miles east and 10 miles north or south of the endangered system.

Potential Remedial Solution: (Local, National, Regional, International)

1. Develop extensive plan to divert, dispense or remove spilled oil before contact

2. Cleanup to degree possible when impacted via predetermined contingency plan.

What Needs to Be Known to Initiate Activity:

Environmental systems deemed to be of such great importance need to be specified and studied.

APPENDIX 1

Oil Pollution Incidents in the Wider Caribbean Region

MARINE POLLUTION BULLETIN

Reprinted from MARINE POLLUTION BULLETIN February 1973 : Volume 4 : Number 2

Pollution and the Offshore Oil Industry

Gulf of Mexico—Spring 1970

The accident occurred when Platform Charlie, producing about 3,000 barrels of oil and 31,000 m^3 of gas per day caught fire (Oil Pollution Incident, 1970). Platform Charlie is located, in about 12 m of water, on block 41 of the Main Pass Field off Louisiana, and was unmanned. Twelve wells had been drilled from the platform of which five were active and producing. The fire was snuffed out using a dynamite charge, some wells were shut off at the platform while the others were choked from below either by drilling intercepting holes or by natural causes (sanding-up). Control was accomplished some 8 weeks after the initial fire, during which time an estimated 35,000-65,000 barrels were spilt.

While the fire burned oil pollution was limited enabling the operating company time to organize booms, skimmers and other equipment. These, together with dispersants used in the vicinity of the platform appear to have been moderately effective and little coastal contamination occurred.

Gulf of Mexico—December 1970

Platform 'B', located in 17 m of water in Bay Marchand, had twenty-two producing wells (Berry, 1972; Nelson, 1972; *Ocean Industry*, 1971). A down-hole problem developed with one well (B21) and the safety choke was removed to allow maintenance operations. A blow-out and fire occurred which affected a number of other wells. Five mobile rigs were rapidly collected to drill into the formations close to the wells feeding the fire. Connections with damaged wells were made and the wells sealed off, the operation taking about 8 weeks. Although the fire was allowed to burn to minimize oil pollution, an estimated 53,000 barrels of oil escaped (*Oversight Hearings on OCS Lands Act*, 1972). Platform 'B' was producing 17,500 barrels per day before the accident.

LaFitte Field, Louisiana - Oil Spill

Spill Location:	LaFitte Oil Field
Date:	September 1971
Type of Oil:	Highly viscous emulsion
Amount of Oil Spilled:	Not available
References:	"Oil Spill Recovery Report, Texaco LaFitte Field," Louisiana, September 1971, Published by Martin Marietta Corp., Denver Div.

Summary:

Oil covered an inland bay area of approximately 9,000 sq ft. The oil slick consisted of a viscous emulsion covered by a thin layer of non-emulsified oil. The total emulsion-oil thickness varied from 1-1/4" to 3", and recovery was accomplished using a sorbent belt elevator type bay skimmer. Recovery rates were estimated to be in the 25 to 50 gpm range. A large quantity of debris was mixed with the oil, but reportedly this caused little trouble. Recovered oil was transferred from the skimmer to a burn pit adjacent the spill site, and in a period of six hours 9,000 gal of oil were estimated to be recovered and burned. Skimmer storage was only 8 bbl. The skimmer was found effective near to shore and was operated for four consecutive days recovering an estimated 16,000 gal of oil.

Shell Bay Marchand Oil Well Blowout

Spill Location:	65 miles south of New Orleans, Louisiana (7 miles from shore)
Date:	December 1, 1970
Type of Oil:	Crude Oil
Amount of Oil Spilled:	Unknown
References:	"Pollution Control Aspects of the Bay Marchand Fire," W. L. Berry, Journal of Petroleum Technology, March 1972, pp. 241-249.

Summary:

Soon after the Bay Marchand blowout occurred, the decision was made to stop the flow of oil from the damaged wells prior to extinquishing the fire. Relief wells were drilled, and the flow from the first and largest well was stopped on December 30, 29 days after the fire began. On April 7, 1971 the tenth and final relief well was completed, and the fire was extinguished. The final well was capped from the surface on April 17, 136 days after the fire began. By allowing the oil to burn, the amount of pollution on the water was significantly reduced. Nevertheless, a large number of mobile booms and mechanical skimmers were assembled which recovered a total of 21,000 bbl of oil.

The primary equipment used to recover oil consisted of the Navy boom and a 40 ft x 8 ft conventional double weir skimmer. (A description of the operation of this skimmer is presented in Section II.) The Navy boom has been discussed in connection with the Chevron spill and is pictured in Figure 26. Two 500 ft long sections of this boom were used to divert oil into each skimmer. A total of nine 500 ft lengths of this boom were constructed: two for each of the three weir skimmers, two as standby and one used as a diversionary boom to prevent oil from entering a critical pass into a bay. This boom had the advantage of being able to be quickly assembled from readily available and inexpensive materials. A 500 ft section could be built in 29 hours at a cost of $20/ft. There were significant problems with the operations

Source: Seadock Supplemental Information, Appendix C of the boom, which became damaged by extended use in moderate seas (4 to 6 ft significant wave heights). To repair the boom, a special repair barge was built which could repair the boom at sea. Sections of the Navy boom were replaced by the Bennett boom (a fence boom similar to the one described in Section II). This boom performed adequately and was more durable than the Navy boom.

The effectiveness of the skimmers was limited since they were only capable of operating in seas less than 3 to 4 ft. This confined their operation to approximately 30% of the time. When weather allowed, the skimmers were operated on a 24 hour basis, and during the day helicopters were used to position the skimmers. The skimmers were towed using two 600 hp tugs which were attached to the diversionary booms. Maneuvering was slow since the system speed was limited by the strength of the Navy booms. The skimmer itself and the 2000 bbl skimmer storage barge could safely be towed at higher speeds.

In addition to the primary skimmers, smaller vessels were used to chase oil patches. A skimmer chase boat consisted of a 110-ft work boat converted to a skimming vessel by use of a boom outrigger and a weir skimmer placed in the pocket between the boom and the side of the vessel. By removing the equipment from the water, these skimmers could be moved quickly, but their successful operation was limited to seas of less than 2 feet. One 160-ft seagoing deck barge was used as a skimmer. This barge had a rigid "w" shaped barrier attached to its side and was maneuvered into the oil using two 900 hp tugs. This is the same system which is described in connection with the Chevron oil spill.

To recover oil which reached sheltered waters, weir-type skimmers and sorbents were used. Sorbents were also used to recover oil deposited on beaches. The most common sorbents were polyurethane foam and straw. The oil which reached the shore was highly emulsified, and the sorbents were only marginally effective. All the sorbents were either mats or were contained in bags; no loose straw was ever used. Oil which was deposited on the beach did not penetrate deeply into the sand, and the natural washing of the waves and tide effectively cleaned the oil from the beach.

The only chemicals used to combat the oil consisted of OIL HERDER®, a surface collecting agent, and the chemical dispersants "Corexit 7664" and "Cold Clean." OIL HERDER® at the time was considered an experimental material. It was sprayed on the surf zone adjacent to beaches prior to the time that oil was deposited on the beach. The chemical prevented the oil from penetrating into the sand and allowed the tide to remove the oil effectively. The chemical dispersants were applied using a high pressure water jet in the vicinity of the burning platform. They were used as a safety precaution to prevent the formation of burning floating oil puddles in the vicinity of the platform. The dispersant was used at a rate of 3 gal per 10,000 gal of water.

In summary, the pollution resulting from the Bay Marchand blowout was significantly reduced by allowing the fire to burn while the relief wells were drilled. The oil spill equipment was reasonably effective but could operate only in wave heights less than 3 to 4 ft and was susceptible to damage by wave action.

Chevron Oil Spill, Offshore Louisiana

Spill Location:	Chevron's Main Pass Block 41 Oil Field, Gulf of Mexico, 10 miles east of the Mississippi River Delta.
Date:	Well fire began February 10, 1970
Type of Oil:	Light gravity (about 36°API) paraffin-based crude
Amount of Oil Spilled:	Leak rate 1000 to 3000 bbl/day, total oil spilled between 35,000 and 65,000 bbl
References:	"Oil Pollution Incident Platform Charlie, Main Pass Block 41 Field, Louisiana," by Alpine Geophysical Associates, Inc., Norwood, N.J. for Water Quality Office, Environmental Protection Agency - Water Pollution Control Research Series 15080 FTU 05/71. Personal Communication from R. R. Ayres and P. R. Scott, Shell Pipeline Research and Development Laboratory, Houston, Texas.

Summary:

The fire began on February 10, 1970 and continued burning for one month, during which time oil-collection equipment was assembled. Serious oil pollution began several days before the fire was extinguished and continued until March 31, when the flow from the last wild well was brought under control. A total of 60 vessels and 250 men were involved in the oil recovery effort at a cost of approximately $2.5 million.

The equipment which was assembled to recover the oil was ordered into three lines of attack. The first line of attack is shown in Figure 25, and consisted of a barrier made from anchored barges interconnected with mechanical booms. The barrier was placed approximately 1000' from the leaking platform. Mobile skim boats and a skim barge were located behind the barrier and constituted the second line of attack. Thirdly, a number of fast shallow-draft boats, light-weight booms, and barges with straw and mulchers were available to protect bays and beaches. Dispersants were only used as a safety precaution to protect men working in the platform vicinity from burning floating oil. The dispersants "Corexit 7664" and "Cold Clean" were applied in high-pressure water jets directed at the oil with a maximum concentration of 300 ppm.

Although reports on the effectiveness of equipment used to combat the oil vary, most indicate that the best mechanical containment and skimming devices were effective only in 1 to 2 foot seas. In 3-4 foot seas the effectiveness was approximately 50%, and the best equipment available was completely ineffective in seas in excess of 4 feet. The array of anchored barges was ineffective since currents were often in excess of 1 knot, and oil was swept under the booms. The booms which connected the barges were often damaged by seas in excess of 6 feet. The most effective boom was the Navy boom which is pictured in Figure 26. This boom could be constructed rapidly and remained intact in 6 foot seas. Weir skimmers which had a design similar to that shown in Figure 27 were places in front of the barge-boom barrier. There skimmers were not effective in waves because of the excessive water that was pumped with the oil. The skimmers were connected to diesel-driven centrifugal pumps rated at 400-600 gpm. Unfortunately, the pumps were not self-priming, and they emulsified the oil hindering any secondary oil/water separation.

The second line of attack was relatively effective since the oil often became concentrated in thick rope-like patches. By skimming these long thin patches, the skimmer boats combined recovery rate was estimated to be as high as 2800 bbl per day in the most favorable weather conditions.[+] The skimmer boats concentrated the oil using boom outriggers, and the oil was removed by weir skimmers. Unfortunately, the boats were only effective in seas up to 2 feet. The most effective single piece of equipment was the skimmer barge which had a W-shaped rigid barrier attached to one side. When this barge was towed sideways with tug boats, the oil entered the center section of the W where an overflow weir skimmer was located. The barge had two 1500-bbl tanks on the deck to contain the skimmed fluid.

[+]This contradicts the experience in the Santa Barbara oil spill where the thin rope-like oil slicks hampered skimming operations because they were difficult to locate.

Since little oil entered the shallow bays, the third line of defense, which was designed for use in the bays, was not tested. Men were kept on the Breton Island Bird Sanctuary and were equipped with firecrackers and shotguns to scare birds from oil-contaminated beaches. Oil did reach Breton Island on one occasion, but the straw and incinerators (to burn oil-soaked straw) which were assembled to combat the oil on the shore were largely not used.

A major lesson which was learned from this spill is that oil cannot be cleaned up by the brute force techniques. The massive and expensive barge-boom barrier was ineffective compared to the more mobile self-contained barge skimmer. In fact, it has been estimated that if two barge skimmers had been used, they would have recovered more oil than was recovered by all the equipment which was assembled.

oil spill INTELLIGENCE REPORT

An International Weekly Newsletter from the Center for Short-Lived Phenomena and Cahners Publishing Company

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MASSIVE WELL BLOW-OUT OFF MEXICAN COAST

An estimated 30,000 barrels of crude oil and an unknown quantity of natural gas have escaped daily from Ixtoc I, a Petroleos Mexicanos (Pemex) exploratory well in Bahia de Campeche, since the well blew out and caught fire at 0330 LT on 3 June. The well is located about 80 kilometers northwest of Ciudad del Carmen, Mexico, in the Bahia de Campeche, where Pemex has drilled 11 other exploratory wells without problem. According to a Pemex spokesman, of the 30,000 barrels of oil escaping daily, 15,000 barrels have burned in the well fire, and 15,000 barrels have spilled into the ocean. Pemex said that up to 30% of the spilled oil would evaporate.

The fire at the well destroyed the semi-submersible platform SEDCO 135, originally worth an estimated $22 million. Perforaciones Marinas del Golfo S.A. of Mexico City, Mexico, had contracted the platform from SEDCO, Inc. of Dallas, Texas (Tex.), and then leased it to Pemex. The well had reached a depth of 3,616 meters when the blow-out occurred on 3 June. The escaping oil and gas mixture ignited, reportedly on contact with the operating pump motors on the SEDCO 135 platform. The entire crew of 63 workers evacuated the rig in life boats, according to Pemex. The damaged SEDCO 135 was removed from the area late on 3 June, while fire-boats continued to spray the well with water.

Another marine drilling rig has been dispatched to the well site to begin drilling a relief well, but Pemex does not expect to complete the well for another 3 months. Pemex described the Ixtoc I as "out of control" and predicted the capping operation would not take place until the relief well had been drilled. OSIR learned that Pemex has hired Peterson Maritime Services of New Orleans, Louisiana (La.), as an environmental consultant and the Red Adair Co. Inc. of Houston, Tex., as the fire and blow-out specialist. Oil Mop Inc. of Belle Chasse, La., has been conducting talks with Pemex about its possible participation in the spill response.

A slick at least 96 kilometers long and several kilometers wide has reportedly formed since 3 June. For the cleanup, Pemex has contracted several recovery vessels equipped with booms and other containment equipment. Each vessel has the capacity to recover from 2,000 to 5,000 barrels per day. On the request of Pemex, Statoil, the Norwegian government-owned oil company, has agreed to provide 1,000 meters of boom, 2 skimmers, and assorted support equipment. Each skimmer measures 7 meters long, 2.6 meters wide, and 2.65 meters high, and weighs 6 tons. Each section of boom measures 250 meters long and weighs 5 tons. The U.S. government has been asked to provide air support to transport the equipment from Stavanger, Norway, to Ciudad del Carmen.

The Ixtoc I may become the worst well blow-out in history if the volume of escaping oil and natural gas does not diminish significantly and if the well is not brought under immediate control, according to OSIR sources. A recent incident of similar magnitude, the Ekofisk blow-out in the North Sea on 22 April 1977, resulted in the spillage of about 10,000 tons of crude oil and 500,000 cubic meters of gas before the well was capped on 30 April. At its maximum extent, the Ekofisk slick covered 1,000 square kilometers. OSIR sources have expressed concern that the water currents in the Gulf of Mexico will eventually carry the spilled oil westward and then northward off the Mexican coast and toward Texas. No reports have yet been received about the spill movement or the environmental impact.

oil spill INTELLIGENCE REPORT

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MASSIVE SPILL CONTINUES AT MEXICAN WELL BLOW-OUT

An estimated 10,000 to 30,000 barrels of light crude oil and an undetermined amount of natural gas continue to escape daily from Ixtoc I, a Petroleos Mexicanos (Pemex) well in Bahia de Campeche, Mexico, since the well blew out and caught fire on 3 June. (OSIR, 8 Jun. 1979, p. 1.) Initial estimates of the oil volume escaping from the well ranged from 10,000 barrels up to 45,000 barrels a day. During the first days of the spill, Pemex said that 50% of the total volume was burning in the fire, and that the remainder was spilling into the Bahia de Campeche. By 9 June, Pemex reported no crude oil was burning in the natural gas fire, and OSIR sources on-scene have confirmed this report.

No oil has yet washed ashore from the Ixtoc I well, located about 80 kilometers northwest of Ciudad del Carmen, Mexico. Mexican biologists reported that, on 12 June, the spilled oil had formed a slick 180 kilometers long and up to 80 kilometers wide. The oil has been surfacing from the well in an emulsion of 60% water and 40% oil due to turbulence encountered as it rises through the wreckage of the SEDCO 135 semi-submersible platform.

The well is still out of control. Pemex officials initially estimated that the capping operation would take more than 3 months, but recently have reported that Red Adair Co. Inc., the blow-out specialists, of Houston, Texas, may be able to bring the well under control by late June. The well pipe has ruptured at a point beneath the water, and Adair is using a 2-man submarine and underwater cameras to survey the rupture. The spilled oil has hampered underwater visibility, but Adair reportedly found the blow-out preventer intact.

Pemex said that the well may be capped soon if Adair can close the underwater valves that the blow-out jammed open. Otherwise, Adair will need to wait 90 to 180 days for the completion of the relief wells. Two drilling platforms are already on-scene to drill the relief wells likely needed to control the blow-out. If the 10,000- to 30,000-barrel-per-day spillage continues for more than 90 days, the Ixtoc I well blow-out will rival the Amoco Cadiz grounding in March 1978 as the largest oil spill in history. The Amoco Cadiz spilled more than 68 million gallons of crude oil after losing its steering and grounding off Portsall, France.

Pemex is using both mechanical and chemical techniques to combat the spilled oil. Peterson Maritime Services of New Orleans, Louisiana (La.), has been contracted to serve as cleanup consultant to Pemex, providing advice on the procurement and deployment of cleanup equipment. On 9 June, Conair Aviation Ltd. of Abbotsford, British Columbia, began large-scale dispersant spraying efforts, applying 2300 gallons of Exxon Chemical Co. COREXIT 9527 dispersant from a specially fitted DC6B aircraft. On 10 June, Conair sprayed 6000 gallons of COREXIT on the Ixtoc I slicks and the following day sprayed 12,000 gallons. OSIR learned that the available supply of dispersants has been the limiting factor in their use on the slicks. Pemex has been transporting the dispersants from Houston to Ciudad del Carmen, in C-130 transport planes. Conair has been using various application rates to determine the optimum rate for different slick thicknesses. Pemex has concentrated the dispersant spraying efforts on patches of oil that broke away from the main slick and that might threaten sensitive areas.

Pemex deployed a skimming system on 12 June, and began recovery operations on 13 June. Two Frank Mohn A/S Framo skimmers have been mounted on a barge anchored 400 meters west of the well, and 750 meters of Norwegian boom have been deployed in a V-configuration attached to the barge to direct the oil toward the skimmers. Two 10,000- to 20,000-barrel barges will shuttle the recovered oil to 2 tankers with a combined capacity of 245,000 barrels. On 13 June, one of these vessels, the Pemex-owned 17,467-DWT Mexican tanker *Plan de San Luis*, was on-scene as the oil recovery began. Pemex expects the system to recover 24,000 barrels of emulsion per day.

Pemex will use the newly designed Shell Oil Co. SOCK skimmer during daylight hours to collect oil escaping from the Framo system. The SOCK skimmer will be used with a 16,000-barrel barge. Pemex will also deploy 2 Oil Mop Inc. (OMI) Mop Machines from an OMI barge located behind the Framo system. OMI in Belle Chasse, La., told OSIR they have dispatched to the spill site a 100,000-barrel barge, 180-foot (1 foot = .3048 meters) workboat, 7 deck-mounted OMI recovery systems, and 2 OMI ZRV dynamic skimmers. Pemex has 3000 to 4000 meters of boom readied to use if the spilled oil threatens ecologically sensitive areas on the Mexican coast and Shell has provided marine biologists to assist in ecological assessments. OSIR learned Pemex is seeking about 10,000 meters of boom from sources outside Mexico.

The spilled oil has restricted shrimping in the Bahia de Campeche, according to biologists at the Centro de Ciencias del Mar y Limnologia (CCML) marine station in Ciudad del Carmen. Two years ago, shrimp boats from Ciudad del Carmen caught 6.5 million kilograms of shrimp, worth an estimated $20 million to the fishermen. Shrimp fisheries extend along the Mexican coast from the tip of the Yucatan Peninsula around the Gulf of Mexico and north to Louisiana. The Campeche Banks, just northeast of the spill site, is one of the Gulf of Mexico's richest shell-fishing areas. Snappers and groupers are the other economically important species in the Campeche Bank. To the west of the spill area, off Veracruz, king and Spanish mackeral are fished commercially. To study the impact of the spilled oil on the marine ecosystem, the CCML station in Ciudad del Carmen plans to conduct cruises in the spill area.

The spilled oil has been moving in a westerly direction at a speed of about .5 knots. North to northeast winds up to 10 knots have been blowing in the spill area, as a cold front moves through the Gulf. Water currents in the region move primarily from east to west and then turn north paralleling the Veracruz coast. The currents average about 1 knot, and at that rate, the oil would take 2 to 3 weeks to move around the Gulf to the Texas and Louisiana coasts. Pemex consultants have reportedly plotted likely spill trajectories and believe the spill does not threaten the U.S. coast. Should oil reach the U.S. waters, it will likely have weathered considerably and formed tar balls.

Less than 60% of the time, winds reach 10 knots in the spill region, and prevailing winds come from the east and southeast during June, July, and August. Over a recent 93-year period, 40 tropical storms orginated in the northwestern Caribbean and southern Gulf of Mexico, and 16 of the storms eventually tracked through the spill region. Hurricanes and strong winds could complicate the slick containment operation. At 1200 LT on 12 June, the National Hurricane Center in Miami, Florida, reported a stationary tropical depression 250 kilometers west of Jamaica. The depression has peak winds of 30 knots, and forecasters expect the storm to eventually drift slowly to the northwest and pass through the gap between the Yucatan and Cuba. If the depression intensifies, the northeast winds in the spill area will likely continue, and perhaps increase slightly.

oil spill INTELLIGENCE REPORT

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CAPPING ATTEMPT FAILS AT MEXICAN WELL BLOW-OUT

The Ixtoc I blew out again on 24 June, less than 4 hours after Red Adair Co. Inc. of Houston, Texas, successfully closed the blow-out preventer, extinguished the fire, and stopped the oil spillage at the Petroleos Mexicanos (PEMEX) well, located in the Bahia de Campeche about 80 kilometers off Ciudad del Carmen, Mexico. (OSIR, 22 June 1979, p. 1.) The Ixtoc I has spilled an estimated 10,000 to 30,000 barrels of crude oil daily and burned an unknown quantity of natural gas since it blew out and caught fire on 3 June.

Adair Co. closed the blow-out preventers shortly after 1000 LT on 24 June, but the resulting pressure reportedly ruptured the well casing below the blow-out preventer. Adair plans to survey the well before deciding whether to attempt another capping effort, although OSIR sources on-scene believe that the capping must now wait at least 10 weeks until 2 directional wells have been drilled to relieve the formation pressure.

The natural gas fire was reignited after the second blow-out to reduce the explosion danger for boats near the well site. OSIR sources on-scene reported the fire appeared brighter and the spill rate greater after the unsuccessful capping attempt. An estimated 5 to 10% of the spilled oil was burning in the well fire, and PEMEX is reportedly studying ways to increase the amount of oil burned. Oil from the well has continued to fan out in a northerly direction.

PEMEX has relied on Oil Mop Inc. (OMI) Mop Machines since mid-June for the mechanical recovery operation. By 21 June, 4 OMI Mark II-9 Mop Machines and a Mark IV-16 Mop Machine, all mounted on the 100,000-barrel OMI barge Genmar 106, had recovered about 3000 barrels of oil. The machines were deployed more than 1 kilometer from the well in patchy oil less than 3 centimeters thick. About 15 OMI employees had arrived on-scene to operate the equipment and train PEMEX personnel in its use. On 22 June, PEMEX moved the Genmar 106 to within 150 meters of the well and then deployed another Mark IV-16 on the barge. The 6 Mop Machines reportedly recovered about 10,000 barrels of oil the following day, and PEMEX plans to operate the Mop Machines 14 hours a day to maintain that recovery rate. OSIR sources report that PEMEX is planning to acquire up to 10 additional Mop Machines.

PEMEX borrowed a Cyclonet 150 open-ocean skimmer from the Southern California-Petroleum Contingency Organization of San Pedro, California (Calif.), and expects to deploy the 75-ton skimmer in the oil recovery operation by 29 June. The skimmer is manufactured by Alsthom Atlantic, Inc. of New Orleans, Louisiana, and has a recovery capacity of about 3000 barrels per hour. The Cyclonet 150 was transported to the spill site from the U.S. on board the Otto Candies Co. supply boat Juanita Candies. On 24 June, PEMEX personnel under the supervision of Alsthom engineers began mounting the skimmer on the Juanita Candies. The Juanita Candies will tow 30,000- to 50,000-barrel barges for storing the recovered oil.

Dispersant spraying has decreased slightly as Conair Aviation Ltd. of Abbotsford, British Columbia, is now flying 1 to 2 spraying missions each day to break up slicks threatening sensitive areas. Conair continues to spray up to 7000 gallons per day and, since operations began on 9 June, has sprayed over 100,000 gallons of Exxon Chemical Co. COREXIT 9527, COREXIT 9517, and COREXIT 7664 dispersants. Exxon has received assistance from a toll manufacturer in Houston, Texas, in order to continue supplying 400 drums of dispersant per day. PEMEX has flown most of the dispersants to Ciudad del Carmen but now plans to transport some of the dispersants by barge.

Four U.S. scientists departed for Mexico on 22 June to work with Mexican researchers in studying the effects of the spilled oil on the fish and shrimp. The scientists represent the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service (USFWS), and the U.S. Environmental Protection Agency (EPA). On 29 June, 2 more U.S. scientists will depart for the spill area to study the characteristics of the slick and to collect wind and current data for spill trajectory models. Four representatives of the Canadian government recently returned from Mexico after observing the well capping and spill cleanup activities for almost 2 weeks.

The spilled oil will likely impact the Tamaulipas, Mexico coast between Tampico and Lower Laguna Madre in 4 to 7 weeks, according to a U.S. Coast Guard (USCG) spill trajectory model. If the spill reaches Rancho Nuevo, about 250 kilometers north of Tampico on the Tamaulipas coast, it will threaten the endangered Atlantic Ridley sea turtle, according to the USFWS. The 500 adult female Atlantic Ridley sea turtles existing in the world breed along a 25-kilometer stretch of beach near Rancho Nuevo. The Atlantic Ridley eggs began hatching in mid-June, and young turtles will continue to emerge until mid-August.

About 100,000 hatchlings will swim west and north in the Gulf of Mexico, primarily on the water surface, during the next 2 months, and the USFWS fears the young turtles will ingest the Ixtoc I oil if they encounter it. Because the loss of a year's hatchlings could drive the Atlantic Ridley sea turtles to extinction, the USFWS plans to work with Mexican scientists to airlift all the hatchlings from the Rancho Nuevo beach to another Gulf of Mexico beach if the spilled oil approaches within about 50 kilometers of the nesting beach.

TANKER SPILLS OIL IN WEST GERMANY AFTER RAMMING

Up to 800,000 gallons of Russian crude oil spilled into the sea locks at Emden, West Germany, after the 59,032-DWT Greek tanker Astoria struck the lock entrance at 0056 LT on 26 June. The ramming holed the No. 1 port cargo tank on the Astoria, which was transporting about 40,000 tons of crude oil from Ventspils, Latvia, and oil leaked from the damaged tank until a water cushion formed, preventing further spillage. The Astoria proceeded into the locks, where most of the spilled oil was contained. The Astoria crew offloaded and steam-cleaned the damaged No. 1 port cargo tank by 1200 LT on 26 June.

Local harbor officials closed the Port of Emden and contracted Sperfina, an Emden company, to conduct the spill cleanup. About 35 Sperfina workers recovered more than 50% of the spilled oil on 21 June using 12 vacuum trucks, 3 barge-mounted vacuum pumps, and 3 floating skimmers. The Astoria was built in 1964 and is owned by Action Shipping Co. S.A. of Panama and operated by Allied Shipping International Corp. of Piraeus, Greece.

4 DIE AFTER SHIPS COLLIDE OFF ITALY

At least 4 people have been killed and up to 5,200 tons of gasoline and gasoil have spilled and burned following the collision of the 7220-DWT Italian motor tanker Vera Berlingieri and the 16,051-DWT French motor carrier Emmanuel Delmas in fog about 35 kilometers west of Fiumicino, Italy, on 26 June at 0630 LT. Although the exact cause of the collision has not been determined, initial reports indicate that the Emmanuel Delmas strayed off course and collided with the Vera Berlingieri at a 90° angle. The engine room of the Vera Berlingieri reportedly exploded immediately after the collision, and fire spread quickly through both vessels, sending smoke over 1500 meters into the air.

Vessels with fire-fighting and anti-pollution equipment were dispatched on-scene from Fiumicino to extinguish the blaze and spray dispersants, but the fire made a close approach to the vessels impractical. The Emmanuel Demas, which was bound from Torre Annunziata to Genoa, Italy, is owned and operated by the Societe Navale Chargeurs Delmas Vieljeux of Paris, France. The Vera Berlingieri, which was bound from Spezia to Vibo Valentia, Italy, is owned by Marittima Rubina S.P.A. of Palermo, Sicily, and operated by Agenzia Marittima Berlingieri, of Savona, Italy.