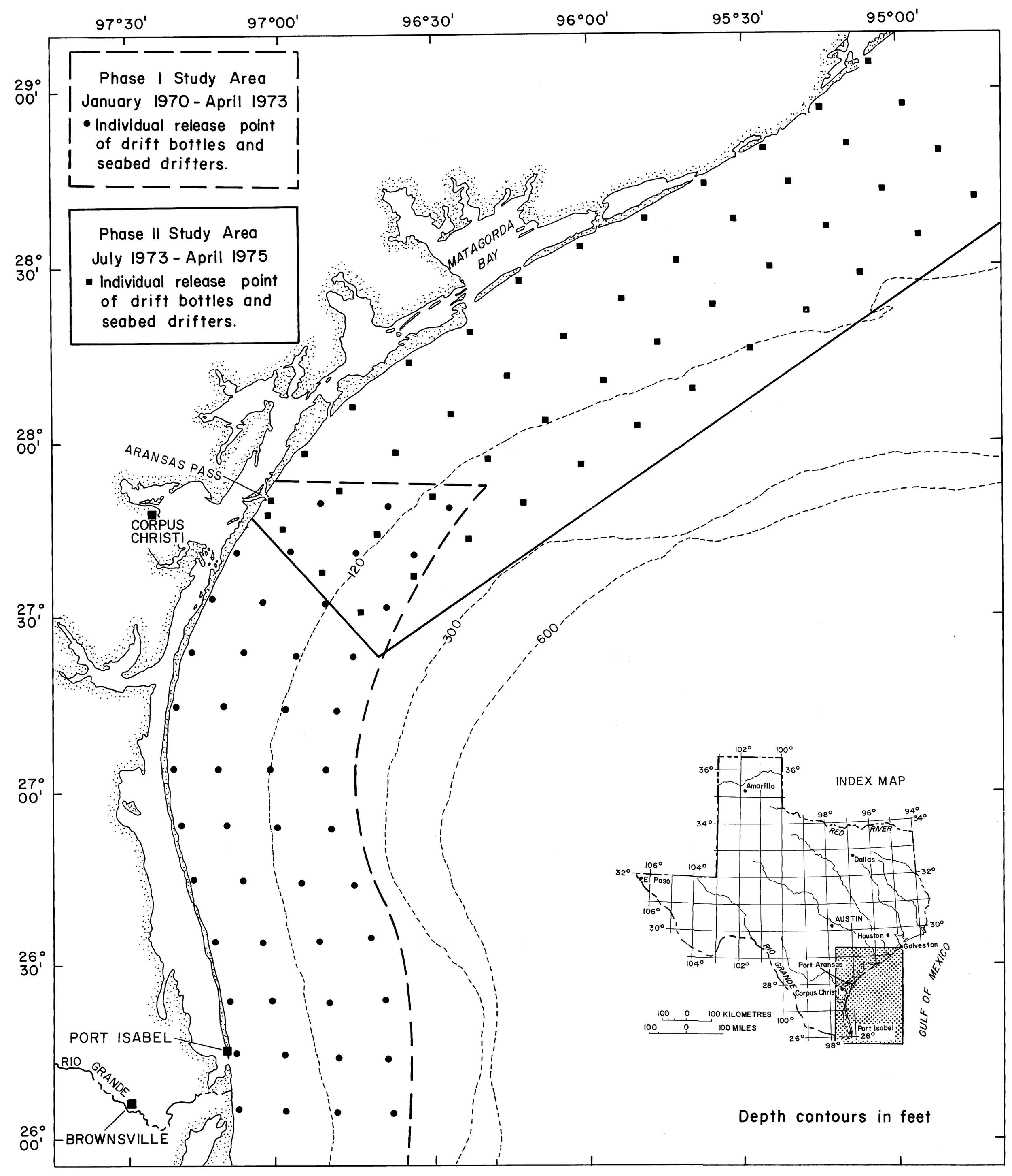


Fig. 1 - Index map of study areas.

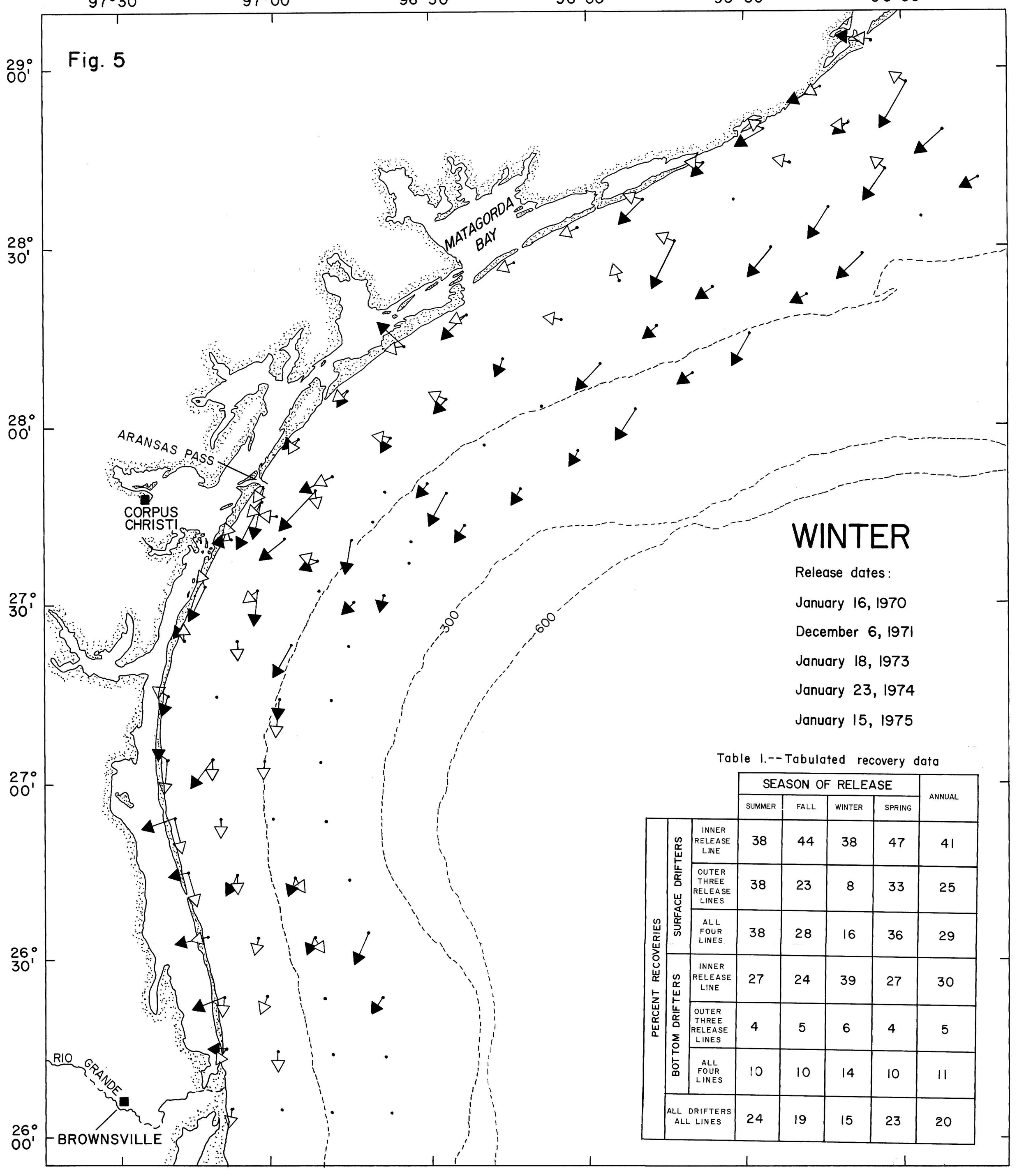


Table 1.--Tabulated recovery data

		Summer	Fall	Winter	Spring	Annual
Percent recoveries, Surface drifters	Inner release line	38	44	38	47	41
	Outer three release lines	38	23	8	33	25
	All four lines	38	28	16	36	29
Percent recoveries, Bottom drifters	Inner release line	27	24	39	27	30
	Outer three release lines	4	5	6	4	5
	All four lines	10	10	14	10	11
All drifters all lines		24	19	15	23	20

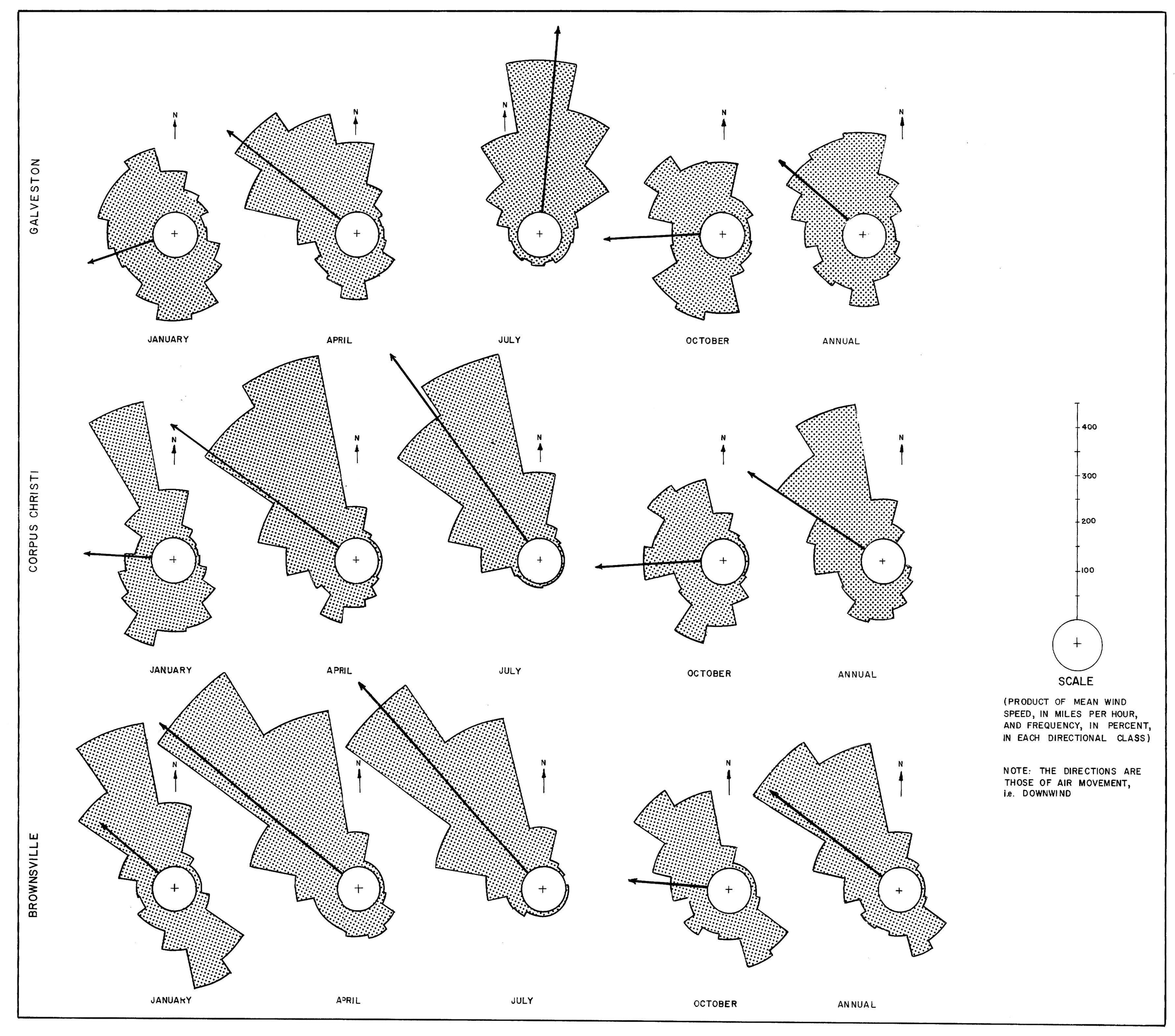
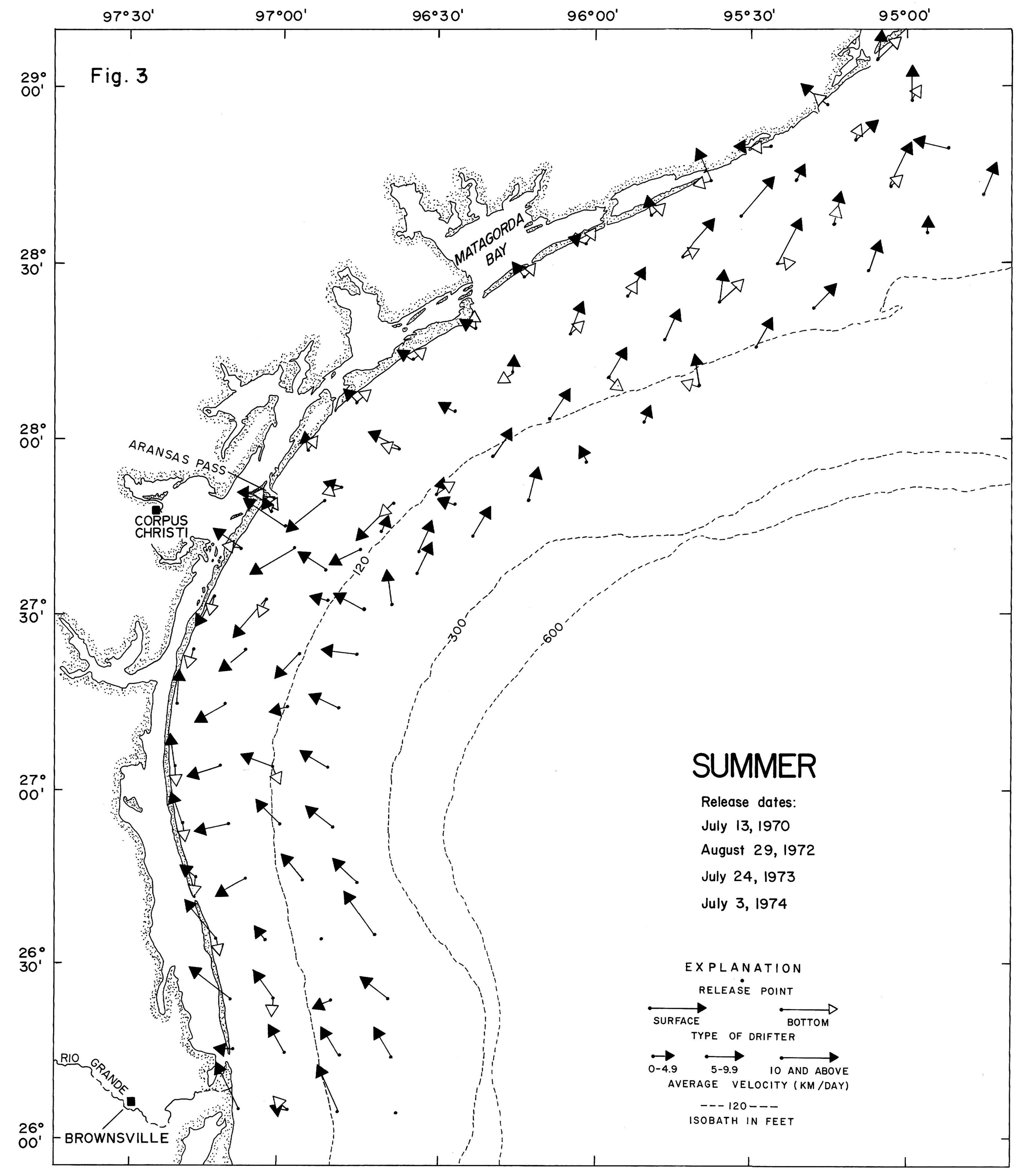
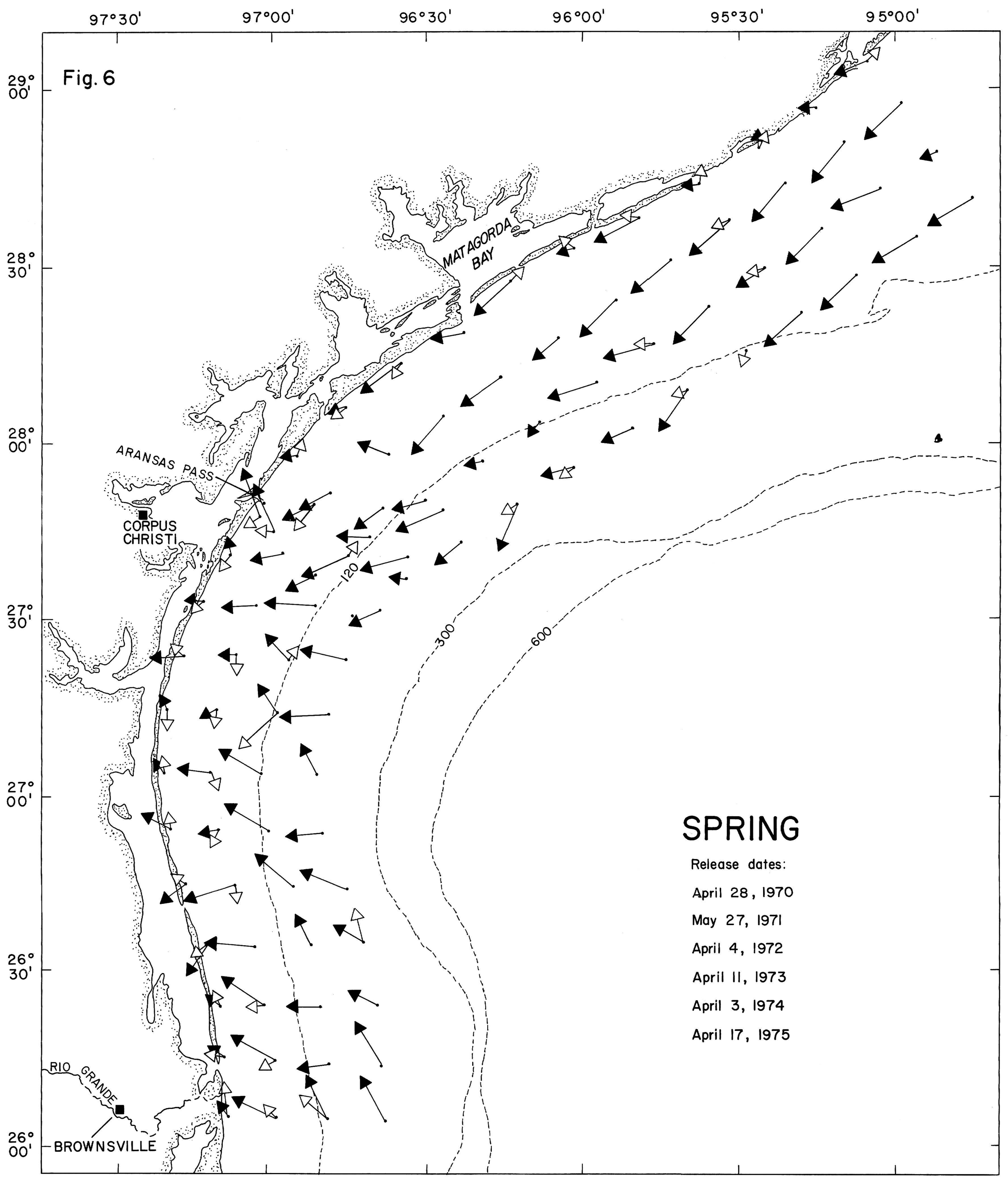
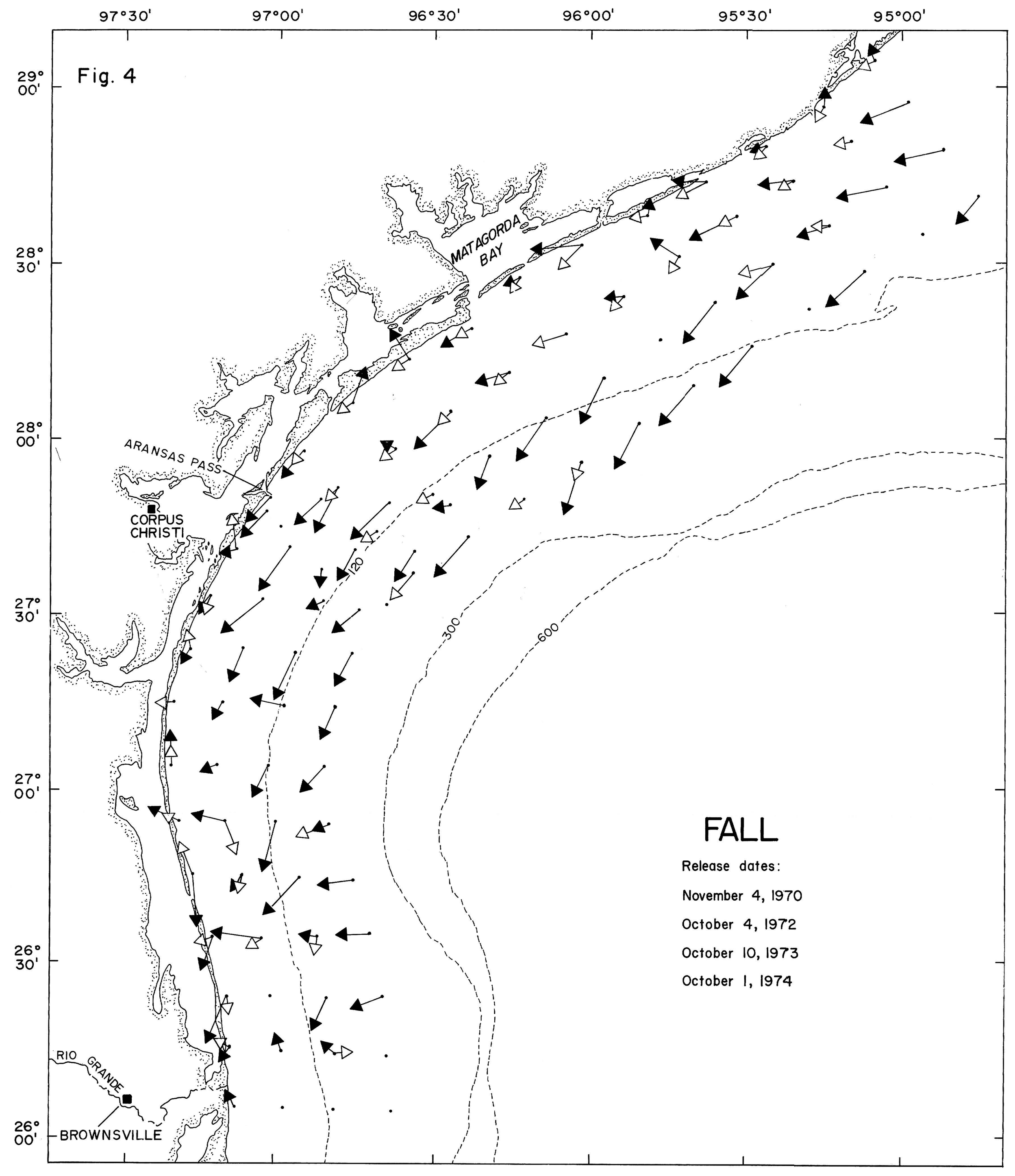
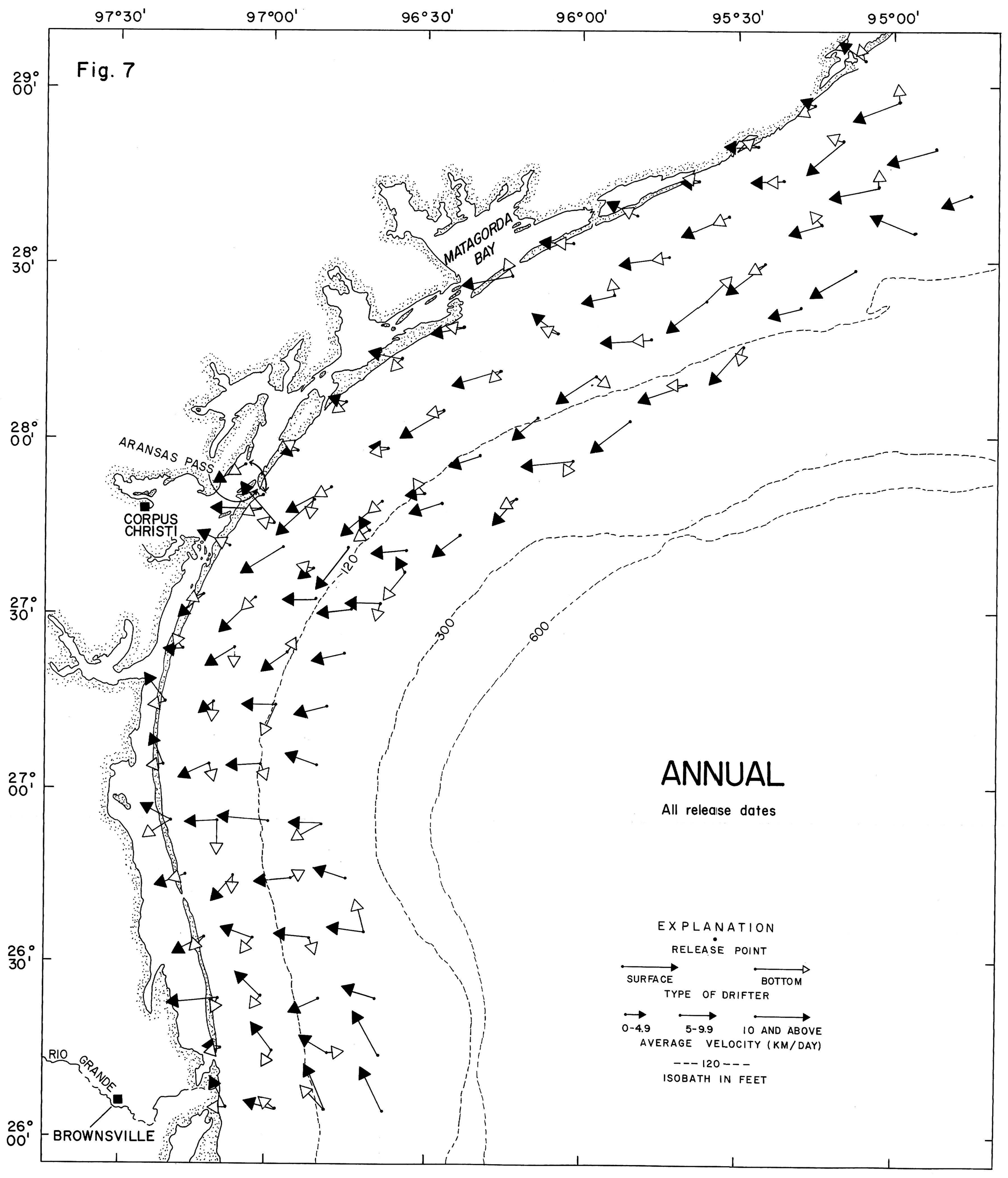


Fig. 2 - Seasonal wind patterns along the Texas coast 1951 to 1960 data (U.S. Weather Bureau, 1962, 1963a,b)









SCALE
0 10 20 30 NAUTICAL MILES
0 20 40 60 KILOMETERS

LAYMAN'S SUMMARY

A series of maps were compiled to show the direction and speed of water movement in the western Gulf of Mexico off the Texas coast. Characteristic drift patterns can be defined on a seasonal and annual basis. Such patterns result primarily from differences in local wind direction and velocity. These drift studies were initiated as part of a U.S. Geological Survey program to study depositional processes and sediment movement off the Texas coast. The United States Coast Guard has applied these data to their SAR (search and rescue) missions. Additionally, a number of private and government organizations utilize these drift data to develop new fisheries activities off Texas.

INTRODUCTION

The results of a multiyear investigation of the speeds and directions of coastal current drift in the northwestern Gulf of Mexico are reported on in summary form. The study was initiated in January 1970 as part of a program to study depositional processes and sediment movement of the Texas coast and was carried out in two phases. Phase I (Hunter and others, 1974) dealt with measuring the coastal drift in the region off south Texas (lat. 26°00'N.-27°50'N.) from 1970 to 1973. Phase II (Hill and others, 1975; Hill and Garrison, 1977) started when the study area was shifted to the north off the Central Texas coast (lat. 27°30'N.-29°00'N.) where drift observations were made from July 1973 to April 1975. The published reports present details about the successive seasonal releases of both bottom and surface drifters in their respective geographic areas.

The net result of all these seasonal studies indicates a yearly cycle of coastwise water movement that is controlled largely by seasonally changing winds. Certain areas are characterized by complex convergences and a stratified water column, whereas other areas have simpler longshore trends. It is also apparent that the characteristic drift pattern of any season can be significantly altered by atypical winds. The result of these studies are summarized in this report on a seasonal and annual basis.

METHODS

Both phases I and II employed the net movement of ballasted drift bottles to measure surface drift, and Woodhead-type plastic seabed drifters to measure bottom drift (Bumpus, 1965). Each study area contained 48 release points that were 22 km apart along four lines roughly parallel to the coast. The lines were generally located 2, 19, 37, and 56 km from the shoreline in water depths of approximately 9, 20, 30, and 46 m. The northern and southern study areas overlapped at about latitude 27°50'N. (fig. 1). On each scheduled release date five surface and five bottom drifters were released at each station by air drops positioned by Loran A or Tacan.

To present the summarized results conveniently, all data from each release point have been reduced to two vectors, one representing average surface drift and the other representing average bottom drift. Vector direction at each station was determined by circular normal distribution; vector length represents the average of all recorded velocities.

RESULTS

The number of returned drifters varied with the season, the distance of release points from shore, and the type of drifters; overall 20 percent of the drifters released were recovered (table 1). Most drifters were collected from the Gulf of Mexico beaches between Galveston and Port Isabel, Texas, although a few were found on beaches north and south of these points, in the lagoons and bays, and by shrimp boats at sea. Recovery of drifters from the line nearest to shore was generally made within 10 days of release. Most recoveries from the outer lines, however, required as much as 60 days from release. Recoveries made more than 60 days after release were disregarded. The net-drift velocities were calculated from straight-line distance and elapsed time between release and recovery and are thus minimum velocities. Calculated values ranged from 0.10 to 46.1 km/day.

The rarity of returns from beaches north of Galveston and south along the Mexican coast may in part be due to factors other than coastal circulation, as these sections are less accessible to visitors. Return of drifters within a few days after each release from points scattered along the entire Texas coastline created confidence in the promptness and geographic representation of recoveries in the study area.

Onshore-offshore components of drift are discussed relative to the trend of the local shoreline off which the drifters were released.

Seasonal Drift Patterns

Summer

Although a large percentage of the surface drifters were recovered (table 1), relatively few seabed drifters came ashore in the summer. Surface drift was generally onshore and to the north throughout except an anomalous area of westward and southwestward drift in the central bend of the Texas coast south of Corpus Christi (fig. 3).

The average pattern of bottom drift is divergent, moving northward along the upper Texas coast and toward the south along the southern coast. No clear offshore-onshore component of bottom drift appears in the outer lines, although the small number of returned seabed drifters suggests a dominant seaward flow. This observation is supported by a small number of seabed drifters recovered by shrimp boats seaward of their release points. As might be expected, measured surface drift velocities were greater than bottom drift velocities.

Fall

The number of surface drifters recovered during the fall was generally lower than that from summer releases, although bottom drifter returns were the same (table 1). Surface and bottom drift were to the south throughout except for part of the lower coast (fig. 4). Surface drift was onshore in the inner half of the area and slightly offshore in the outer shelf, whereas bottom drift was generally alongshore. The drift patterns off the lower coast were more confused. Trends for surface and bottom drift in the nearshore were not definable. Surface drift in the area of the outer lines was to the west and southwest with a strong onshore component, whereas bottom drift was vague, but mainly to the south. Surface-drift velocities in the northern and central sectors of the study area were generally greater than those in the southern sector, and in sum, fall surface-drift velocities were greater than those observed in summer.

Winter

A substantially smaller percentage of surface drifters and a larger percentage of bottom drifters were recovered compared to the preceding seasons (table 1). Winter surface drift was to the south and alongshore, although off the upper Texas coast a strong westerly (onshore) component is evident (fig. 5). Except for some southwesterly drift nearshore in the south, bottom movement was also to the south and alongshore. Both surface and bottom drift velocities were much reduced compared to those of other seasons.

Spring

The numbers of surface drifter recoveries rose in the spring, but bottom drifter recoveries decreased compared to winter results (table 1). Both surface and bottom currents were mainly southward in the northern part of the area, although southward directed bottom drift extended beyond the area of southward surface drift (fig. 6). Surface drift was generally alongshore in the north and onshore in the south, and drift velocities were much greater than those observed in the winter.

Annual

The summation of all drift observations for each station should give an indication of the net annual current movement over the entire study area. The vector patterns suggest a net onshore surface drift to the south off the upper and central Texas coast, a net onshore surface drift to the north off the lower coast, and a region of net westerly (onshore) movement off the south-central coast between the two. Average bottom drift is to the south for the entire coast, and a preferred onshore-offshore direction is not evident. On the whole, drift velocities at the surface were greater than those near the sea floor.

DISCUSSION

Coastwise Components of Drift

A comparison of our data with those of previous drift studies off the Texas coast (for example, Kimsey and Temple, 1964) corroborates the existence of a yearly cycle of seasonally changing winds (fig. 2). In accordance with seasonal variations in wind direction, southward drift is best developed during the winter, whereas northward drift is best developed during the summer. During the spring and fall seasons, drift patterns converge along the south Texas coast. The position of convergence shifts northward during the spring and southward during the fall and appears to have a complex structure in both horizontal and vertical sections through the water column.

The annual result of the seasonal drift pattern is a convergence of surface drift along approximately the 27°00' latitude and a southerly directed drift at the bottom. Southward drift is best developed in the northern part of the area and northward drift is best developed in the south owing to the orientation of the shoreline relative to the predominant south-easterly winds.

Onshore and Offshore Components of Drift

As recovery of seaward-moving drifters is very unlikely, differences between the numbers of bottom and surface drifters recovered are normally the principal evidence of seaward currents to be expected from drift studies. A seasonal reversal of the ratio of surface-drifter recoveries to bottom drifter recoveries would therefore suggest that surface and bottom drift has opposing onshore and offshore components and that these components are reversed seasonally.

The ratio of bottom-drifter recoveries to surface-drifter recoveries on the Texas coast shows significant seasonal variations. In summer, the number of surface-drifter recoveries tends to be large compared to the number of bottom-drifter recoveries. In the winter the number of bottom drifters recovered increases, and the return of surface drifters greatly diminishes. This pattern of recoveries suggests that onshore surface drift is best developed during the summer months and onshore bottom drift is best developed during winter conditions.

Onshore surface drift during the summer is a result of the predominantly onshore southeasterly winds. The tendency to offshore drift during the winter is related to northerly winds, which are common at this time and which usually have at least slightly offshore components. Onshore or offshore components of bottom drift in opposition to the components of surface drift are to be expected from the steady state requirement that no net flow normal to shore can exist.

More detailed discussion and explanation of rates and directions on drift relative to seasonal variation in wind direction, drift convergences, and onshore-offshore components of drift are presented by Hunter, Hill, and Garrison (1974). The effects of onshore-offshore drift on beach profiles have been discussed in several papers including Hunter and others (1972) and Fox and Davis (1976).

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MAPS SHOWING SEASONAL DRIFT PATTERNS ALONG THE TEXAS COAST, 1970-1975: A SUMMARY

BY

GARY W. HILL AND LOUIS E. GARRISON

1978