

DISTRIBUTION OF BROWN SHRIMP (*Penaeus aztecus aztecus* IVES) AS RELATED TO TURBID WATER PHOTOGRAPHED FROM SPACE¹

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ABSTRACT

Visual evidence of probable relief currents in the northwestern Gulf of Mexico is provided for the first time by photographs taken from Gemini spacecraft. After rectification of photographs of the Continental

Shelf off the Texas Coast, a comparison of the position of relief currents to areas of high shrimp production indicates that photography from space can be a valuable tool for fishery research.

Oceanographers long have predicted the existence of relief or rip currents between Galveston and Corpus Christi, Tex. (Sweitzer, 1898; Smith, Medina, and Abella, 1951; Curray, 1960), and navigators have called the area the "Whirlpool of the Gulf" (U.S. Coast and Geodetic Survey, 1949). The offshore relief currents result from the convergence of southerly and northerly currents, which causes a piling up of water that is relieved by an offshore flow. The buildup and eventual release of waters in the Galveston-Corpus Christi area are continuously recurring sequences of events related to the total Gulf system.

Visual evidence of countercurrents, which have never before been documented by oceanographic techniques, is apparently provided by figure 1. This figure is a reproduction of a color photograph taken by NASA (National Aeronautics and Space Administration) from an altitude of 330 km. on November 14, 1966. In addition to showing the distribution of suspended material in bay and Gulf waters, the discharge patterns from the bays, the major eddy currents, and the relative direction of the currents, we believe it illustrates clearly the long-suspected phenomenon of rip or relief currents.

Sediments in the water provide the contrast that permits us to see the interaction of the coastal current systems. Perhaps the most obvious feature is

the discharge of sediment at the entrances to Lake Charles, La., and Sabine Lake and Galveston Bay, Tex. Large volumes of sediment in these areas are being carried into the Gulf and immediately transported southward by an alongshore current. Less noticeable but vastly larger are two areas of discolored water south of Galveston that extend eastward. These plumes of suspended material are aligned by moving water and most likely represent the areas of rip or relief currents predicted by oceanographers. The plumes, outlined in figure 2, are believed to be semipermanent features of the Gulf current system, although their locations, intensity, and dimensions undoubtedly fluctuate throughout the year. Obviously, they must have some effect on the bottom sediments and nutrient supply.

Our conclusions admittedly are conjectural because of the lack of necessary detailed physical and chemical data from oceanographic and bottom surveys made in and around the areas under consideration. A definite relation does exist, however, between the shrimp catch, trawling frequency, and the plumes shown in figure 2.

Rectification of the Gemini photograph to ONC (Operational Navigation Chart) No. 24 (fig. 3) revealed that the plumes were in BCF (Bureau of Commercial Fisheries) statistical area 19 and the lower portion of area 18 (fig. 4). The best

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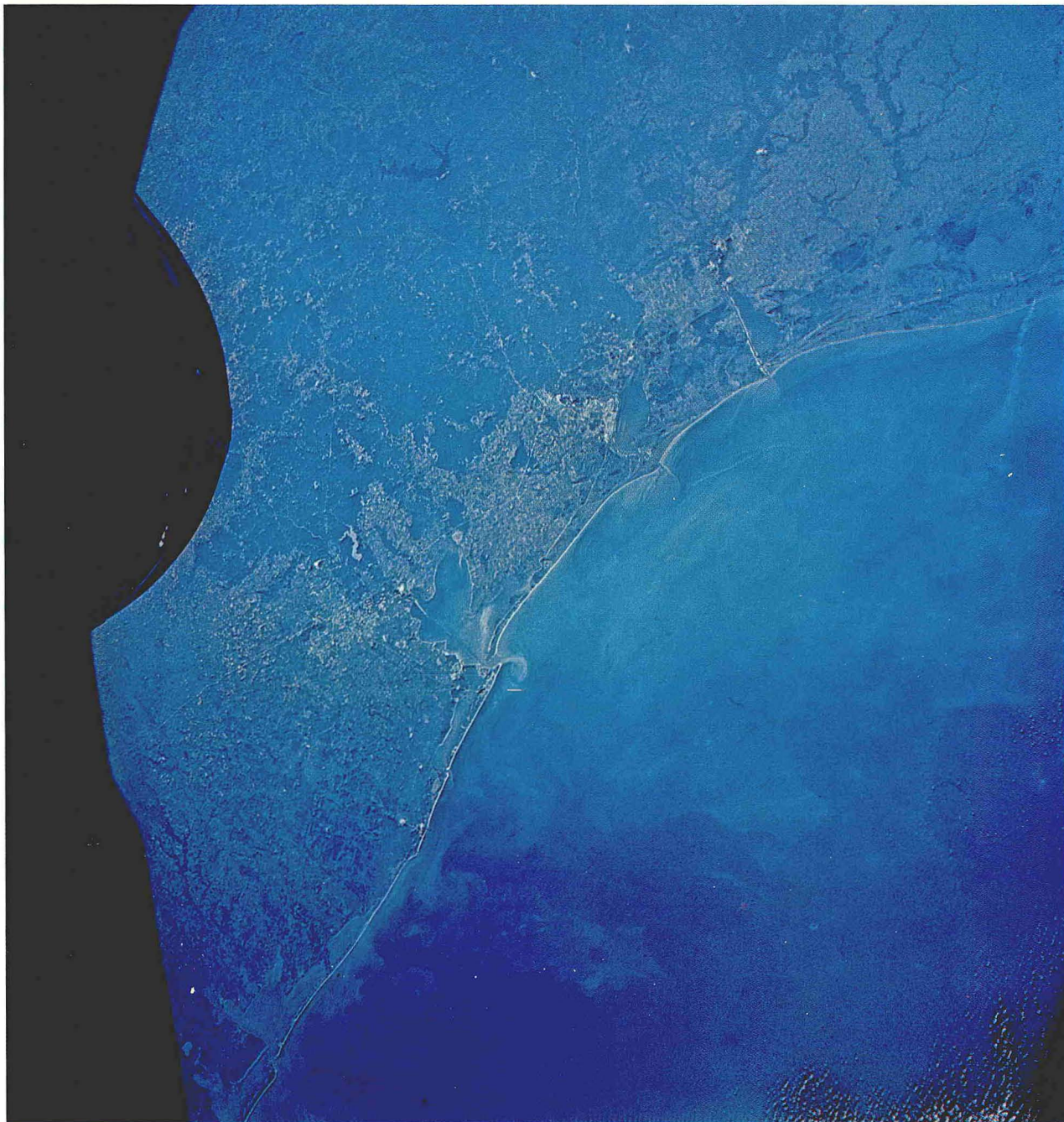


FIGURE 1.—An unrectified Gemini photograph of the northwestern Gulf of Mexico, from an altitude of 330 km. Matagorda Bay, Tex., is to the lower left and White Lake, La., to the upper right. The direction of the wind can be determined from the smoke trailing offshore near White Lake. The discharge patterns from the bays and the southerly along-shore currents are plainly visible. What appear to be offshore relief currents are evident south and east of Galveston, Tex. The white dots along the right margin are clouds; a portion of the Gemini craft is on the left margin. (NASA color photograph S-66-63034, taken by James A. Lovell, Jr., and Edwin E. Aldrin, Jr., November 14, 1966 (1300 hours local time), during Gemini Flight XII).

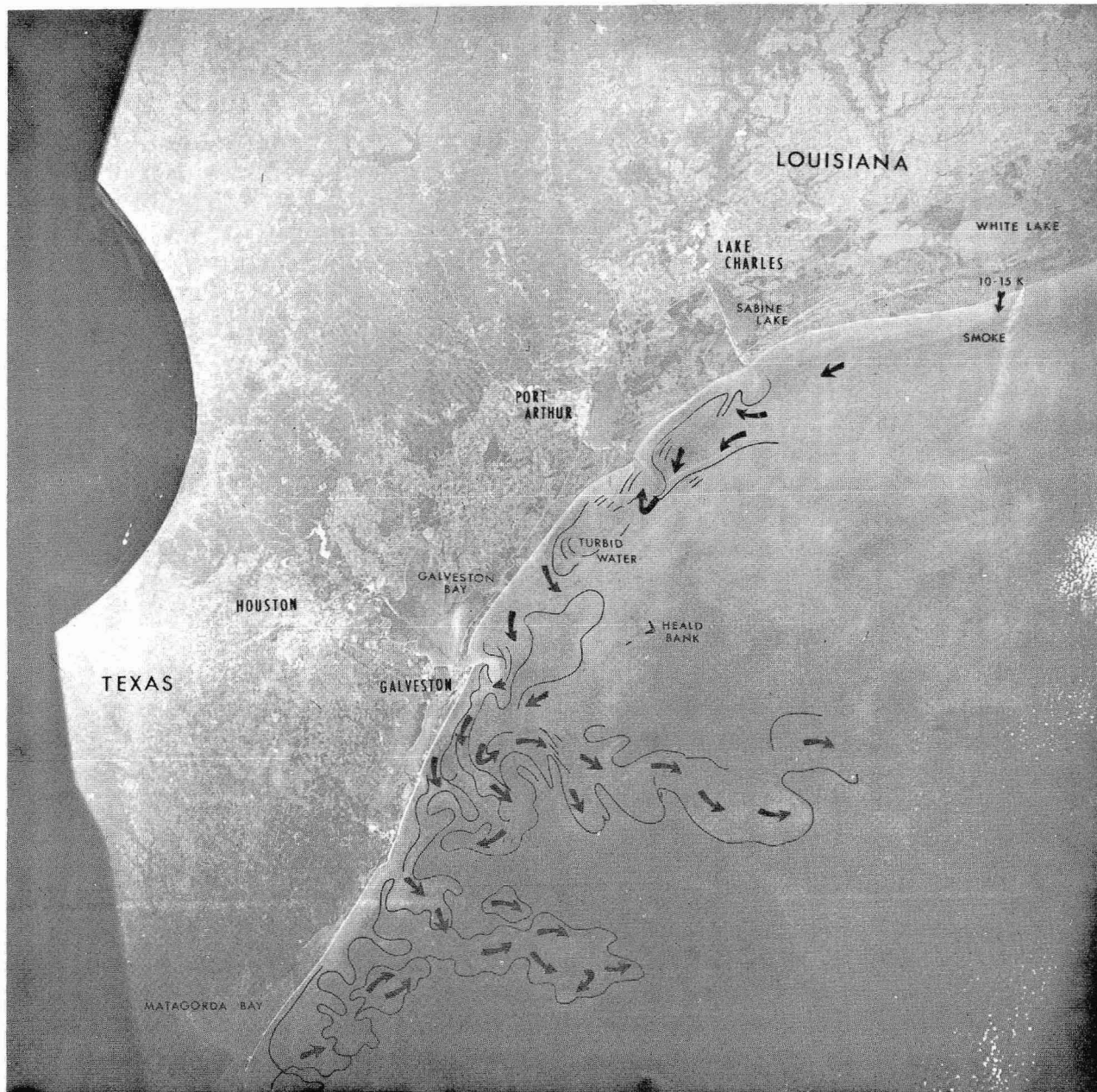


FIGURE 2.—This reproduction of figure 1 shows the alongshore southerly currents and what we believe to be the offshore relief or rip currents south and east of Galveston, Tex.



FIGURE 3.—An image of *ONC No. 24*, superimposed over a portion of figure 1 (rectified). The plumes have been outlined, and the directions of the currents are shown by arrows.

fishing grounds for brown shrimp (*Penaeus aztecus aztecus* Ives) in the northern Gulf of Mexico are known to be consistently in this region. In November 1966 (when the Gemini photograph was taken) about 57 percent of the catch of brown shrimp along the Texas Coast came from statistical area 19 and about 54 percent of the fishing effort was expended in this area (table 1). In 1956-66 about 43 percent of the brown shrimp caught in Gulf waters along the Texas Coast came from statistical area 19 (table 2).

Additional evidence for the relation between the plumes and brown shrimp fishing is provided by data gathered in July-September 1964 by personnel of the BCF Biological Laboratory, Galveston, Tex. During this period, which is the height

TABLE 1.—Catch and fishing effort for brown shrimp, by statistical areas, in the Gulf of Mexico along the Texas Coast, November 1966¹

Statistical area	Catch		Effort (trips)	
	Metric tons	Percent	Number	Percent
18.....	36.7	4.0	113	9.5
19.....	450.4	56.9	684	54.4
20.....	99.4	12.6	166	13.2
21.....	205.5	25.9	288	22.9
Total.....	792.0	100.0	1,257	100.0

¹ Source: Gulf Coast shrimp data, reported by depth and area of capture, species, size, number of trips, and days fished, November 1966. U.S. Fish Wildl. Serv., Curr. Fish. Statist. 4358.

of the brown shrimp season, an extensive interview campaign was undertaken to determine, by 10-minute grids, the areas most frequented by vessels fishing for brown shrimp. These data have been

TABLE 2.—Catch of brown shrimp (heads-off), by statistical areas, in the Gulf of Mexico along the Texas Coast¹

Year	Statistical area					Total
	18	19	20	21		
—————Thousands of metric tons—————						
1956	2.2	3.1	3.3	1.4		10.0
1957	2.4	5.3	3.4	1.6		12.7
1958	2.2	2.8	4.6	1.3		10.8
1959	2.3	4.9	3.6	2.5		13.4
1960	3.4	7.0	2.9	1.7		15.0
1961	1.1	2.5	2.1	1.3		7.0
1962	1.0	3.4	2.4	.8		7.6
1963	1.6	6.1	2.0	1.8		11.5
1964	1.2	4.0	2.4	1.0		8.6
1965	1.9	6.4	1.9	1.6		11.8
1966	1.3	5.7	2.6	2.0		11.6
Total	20.6	51.2	31.2	17.0		120.0
Percentage	17.1	42.7	26.0	14.2		100.0

¹ Source: Published records of the U.S. Department of the Interior, Bureau of Commercial Fisheries.

superimposed on the rectified Gemini photograph in figure 5. Clearly, fishing intensity was heaviest in and near the plumes.

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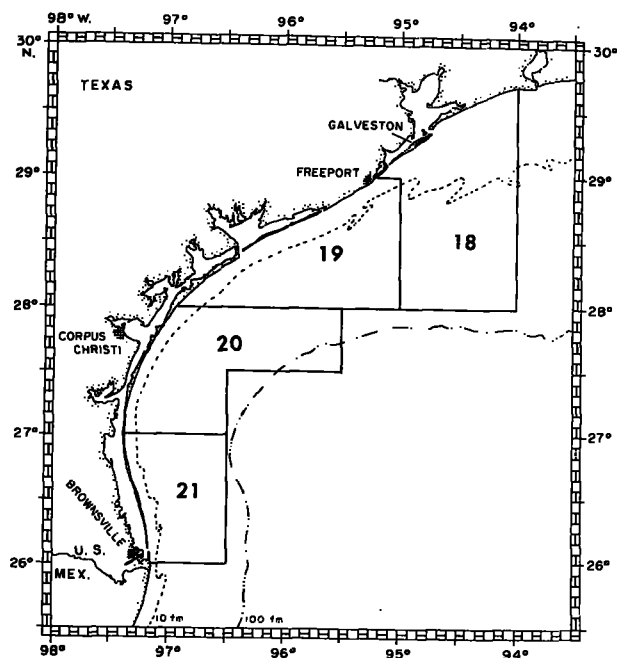


FIGURE 4.—Statistical areas along the Texas Coast. By interviewing fishermen, BCF employees are able to record data on daily landings and fishing effort by statistical area. The recording of catch and effort by this method began in January 1956. Comparison of this figure with figure 3 shows that the relief plumes lie in statistical area 19 and the lower portion of 18.

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FIGURE 5.—An overlay on figure 3 that demonstrates the relation between the plumes and fishing intensity for brown shrimp. The numbers in the 10-minute grids represent the total number of vessels fishing in each grid in July-September 1964. Only those grids are numbered where 25 or more vessels fished.