CHAPTER 96

LITTORAL DRIFT ALONG BAYSHORE OF A BARRIER ISLAND

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INTRODUCTION

A barrier island is an easily recognized geographical land feature along the south-east Atlantic and Gulf of Mexico coasts of the United States. It is characterized by a large ratio of length to width. It has a bay on one side and an ocean on the other. The inlets, on the ends, connect the bay to the ocean. The sand movement along the bayshore side is subjected to steeper and shorter waves which respond to local wind conditions. The physical boundary constraint of a bay is also different from open coast shorelines. Virtually no information exists with regard to the littoral drift rate on a bay shoreline. This paper tries to answer the question of whether or not the drift on the bay shoreline is different from that of the open coast since it is under different wave climates and physical constraints.

STUDY AREA

Santa Rosa Island is a barrier island situated on the west end of the Florida panhandle. It has the Gulf of Mexico on its south side and Santa Rosa Sound to its north. This barrier island has 48 miles of sand beaches on its Gulf and bay shores, which stretch eastward from Pensacola Beach to Fort Walton Beach. The average width, however, is approximately 1.5 miles. Santa Rosa Sound is 44 miles long and 2 miles wide. The study area was a highly-developed recreational community. A location map of the study area is given in Figure 1.

FIELD MEASUREMENTS

The breaker height, breaker angle and the longshore current were measured during the sampling operation (Wang et al, 1977). They are shown in the following table.

TABLE I

Date Mon./day	Breaker height (cm)	Breaker angle (degree)	mean longshore current u(cm/sec.)
2/15	15.2	11	7.4
2/15	12.7	10	7.0
2/16	10.2	9	7.4
2/16	11.4	10	6.2
2/17	8.9	12	10.5
2/17	10.2	7	5.7
2/18	15.2	10	5.1
2/18	12.7	12	8.8
2/19	15.2	13	7.2

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The sand tracing mehtod was used for determining the littoral transport rate. Sand was collected from the study site shortly before the tracing operation. This sand was coated with four colors of fluorescent dye in the Coastal and Oceanographic Engineering Laboratory (COEL), University of Florida. One hundred pounds of each of the four colored tracers were then injected back into the shoreline. A dredge-type sand sampler was used for collecting the samples, and the sampling stations were according to the predetermined coordinate system shown in Figure 2. Each sample was put into a sampling cloth bag with the station number marked on the label, and then sorted into sample sets for shipping to COEL for tracer counts in Gainesville. A series of equal concentration contour maps were produced. Figure 3 shows equal concentration contours for the blue tracer. The centroids of each contour map were calculated, and their longshore co-ordinates $(y_\ell)_i$ were determined. $i = 1,2,3....$.

A tide gage and a wind anemometer were installed near the study area. Tidal curves and wind roses can be found in the report by Wang et al, 1977.

ESTIMATION OF LITTORAL TRANSPORT RATE

The water depth at the study site was shallow. The shoreline slope was rather flat with transverse bars at an angle with the shoreline (Wang et al, 1977). Wave conditions and currents at the study area correspond directly to the local winds. In order to account for the wind and tide induced currents it is considered that Bagnold's (1963, p. 518) formulation would be more appropriate for the present study,

$$I_\ell = K' \, w \frac{u}{u_m} \tag{1}$$

where the immersed transport rate is I_ℓ, the wave power $w = (EC)_b \cos\alpha_b$, E is the wave energy density, C the wave group velocity, α the breaking angle, subscript b meaning at wave breaking condition; the maximum orbital velocity $u_m = \sqrt{(2E/\rho h)}$; ρ is the water density; h, the water depth, and u is the average longshore current in the surf zone. The quantity $w(u/u_m)$ may be calculated from the field measurements in Table 1. I_ℓ is determined through the sand tracing technique. The longshore component of the advective velocity of the beach sand (considered same as the tracer sand) is calculated as

$$V = \frac{(y_\ell)_2 - (y_\ell)_1}{t} \tag{2}$$

where t is the time between sampling operations. The active depth d of the moving layer of beach sand was obtained by examining the eroding depth of a buried tracer column. It was determined to be 1/8 of an inch for the study area. The volume transport rate S_ℓ is then,

$$S_\ell = v \, d \, B$$

where B is the surf zone width. This volume transport rate S_ℓ is related to I_ℓ by $I_\ell = (\rho_s - \rho) g \beta S_\ell$. ρ_s and β stands for the density and the porosity correction of sand respectively.

The transport coefficient K' in equation (1) was determined by the data which were derived from the four color tracers; each color consisting of nine sample sets. Only the blue tracer is presented here in Table 2.

TABLE 2

Sample sets	Date Mon/day/year	Time EST (hour)	I_ℓ NT/Sec.	$W(u/u_m)$ Joules/Sec. M	K'
1	2/15/77	14:00	1.64	7.25	0.23
2	2/15/77	21:00	0.44	4.75	0.09
3	2/16/77	10:00	0.69	3.25	0.21
4	2/16/77	15:00	0.24	3.40	0.07
5	2/17/77	10:00	0.29	3.60	0.08
6	2/17/77	16:00	0.28	2.50	0.11
7	2/18/77	10:00	0.77	5.10	0.15
8	2/18/77	16:30	1.46	6.08	0.24
9	2/19/77	12:00	1.39	7.00	0.20

I_ℓ's for the blue tracer in Table 2 as well as for other three colors were then plotted against the quantity of $w(u/u_m)$. A regression line through the data points was drawn and shown in Figure 4. The regressional transport coefficient was determined to be K' = 0.18. The statistical analysis of the data, including the test of fit of the data, may be found in Chang (1978), Chang and Wang (1978).

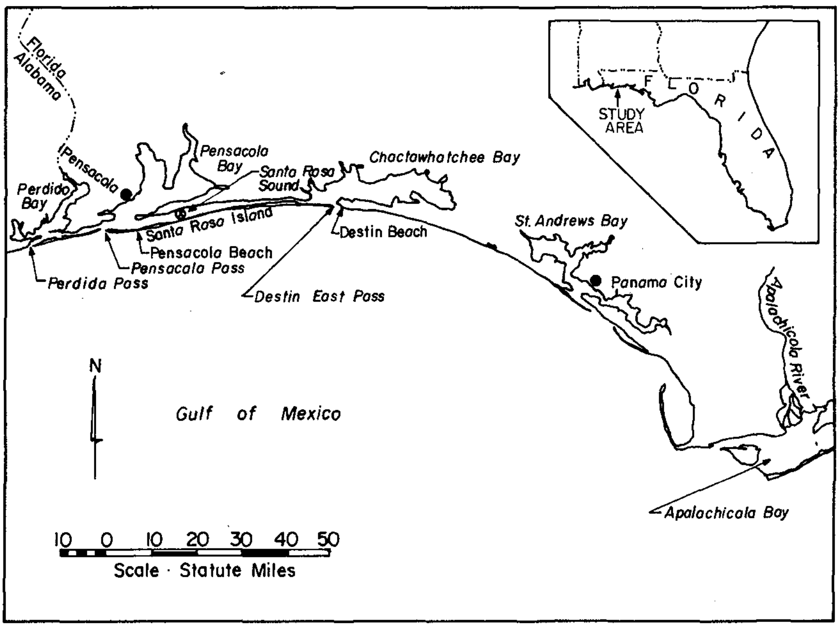

Figure 1. Study Area Map

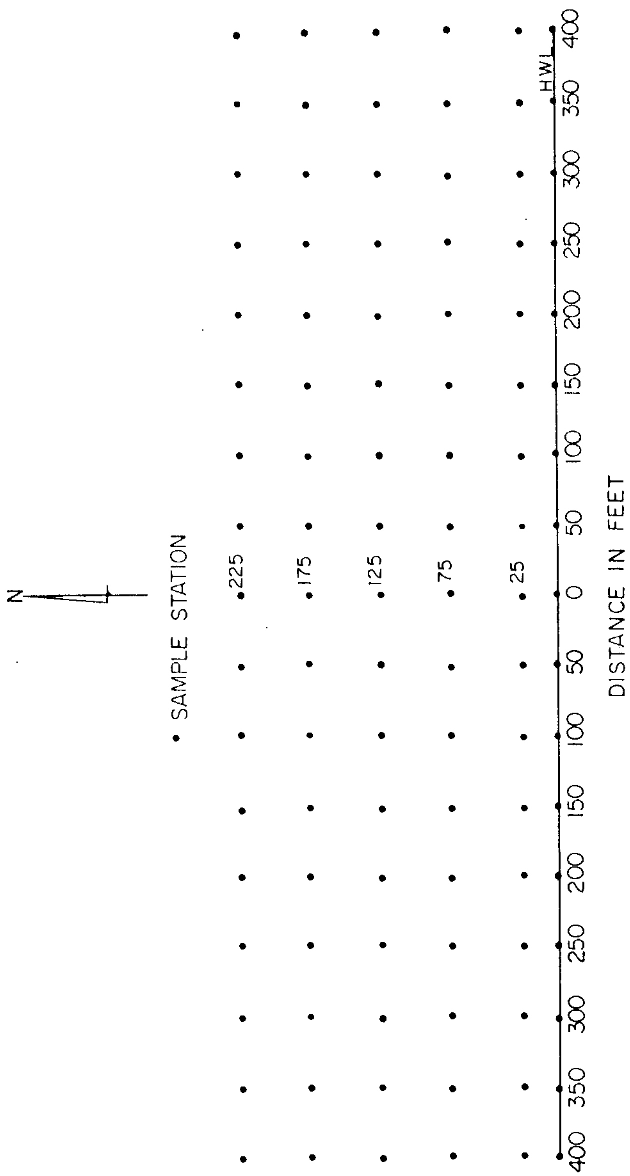

Figure 2. Grid Coordinate System

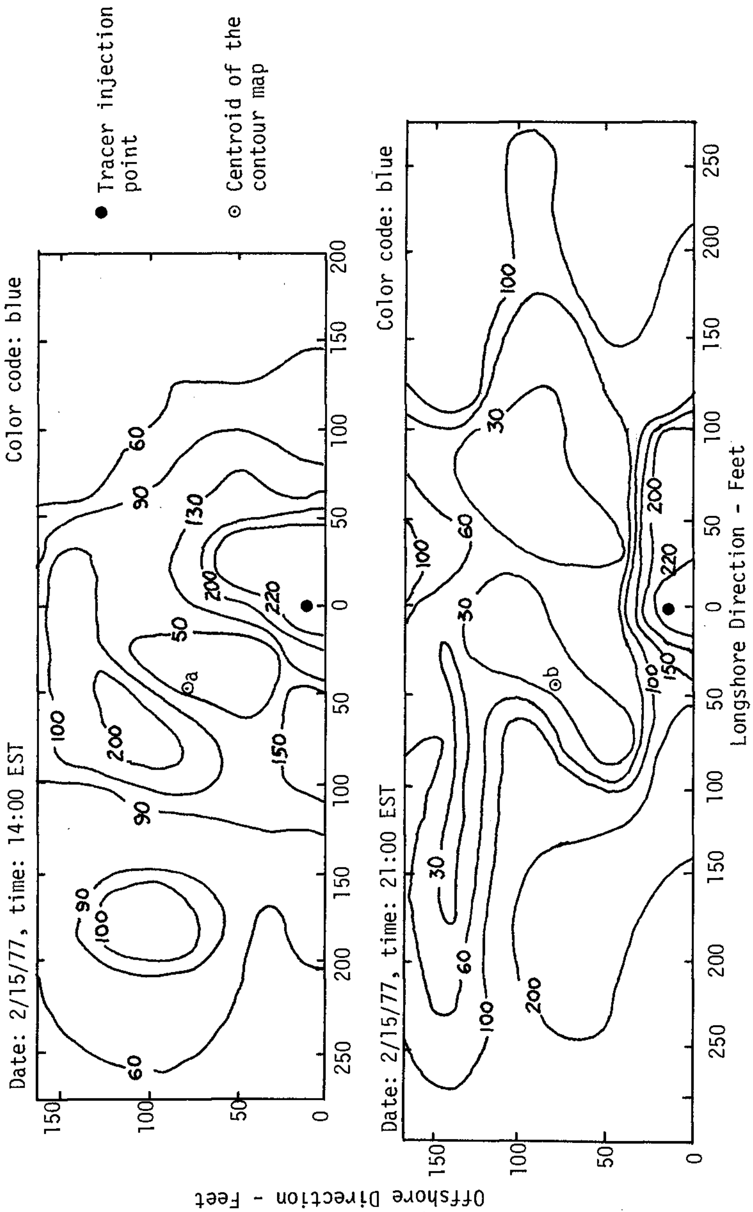

Figure 3. a and b, Equal Concentration Contour Maps

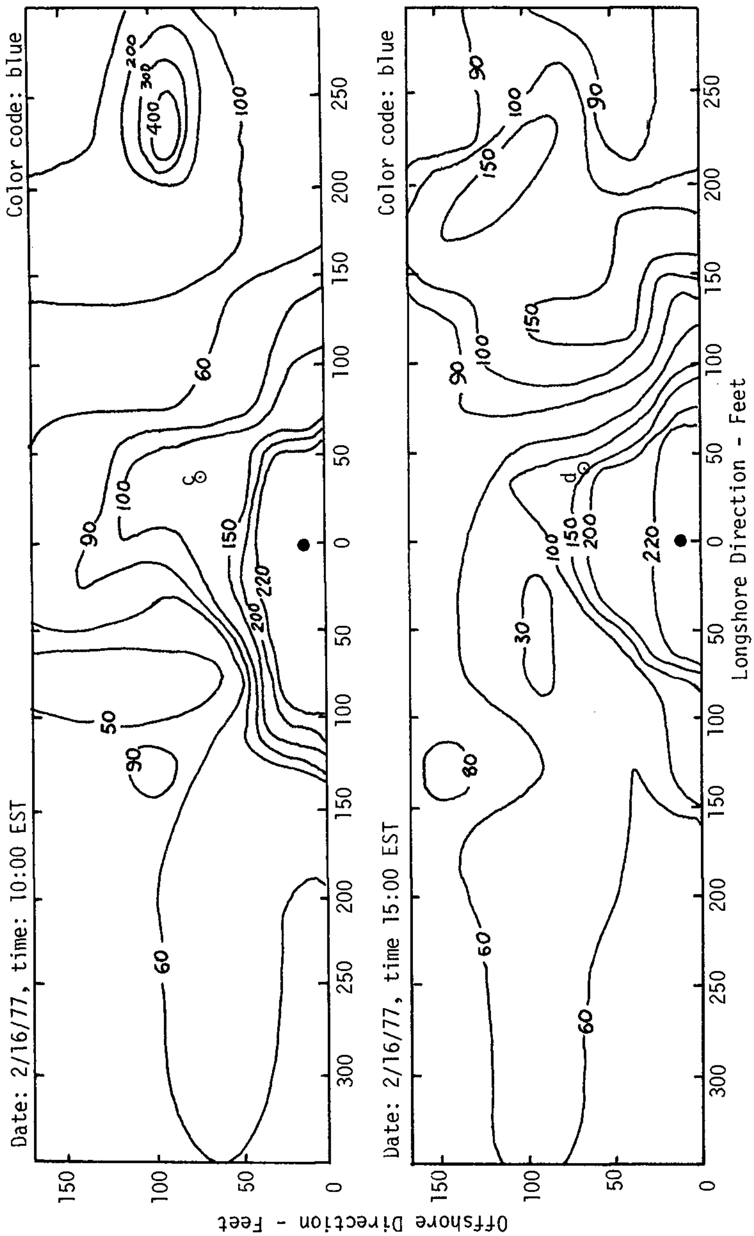

Figure 3. c and d, Equal Concentration Contour Maps

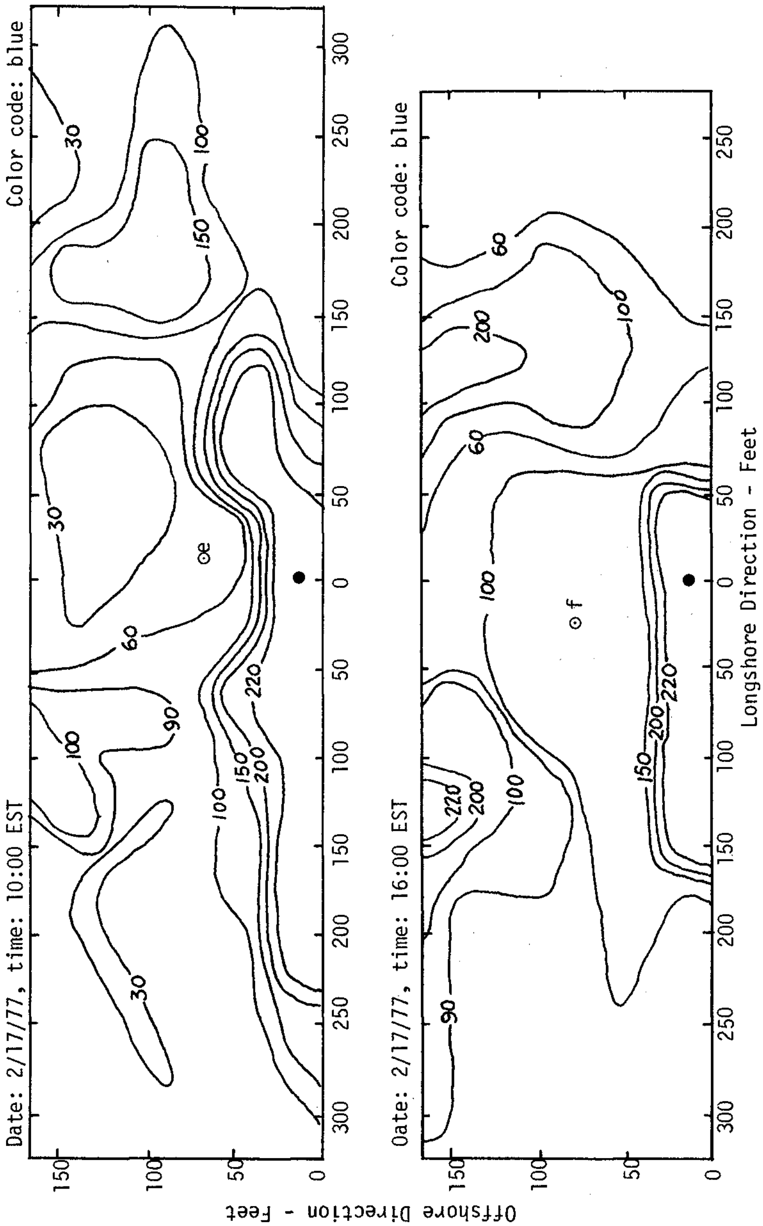

Figure 3. e and f, Equal Concentration Contour Maps

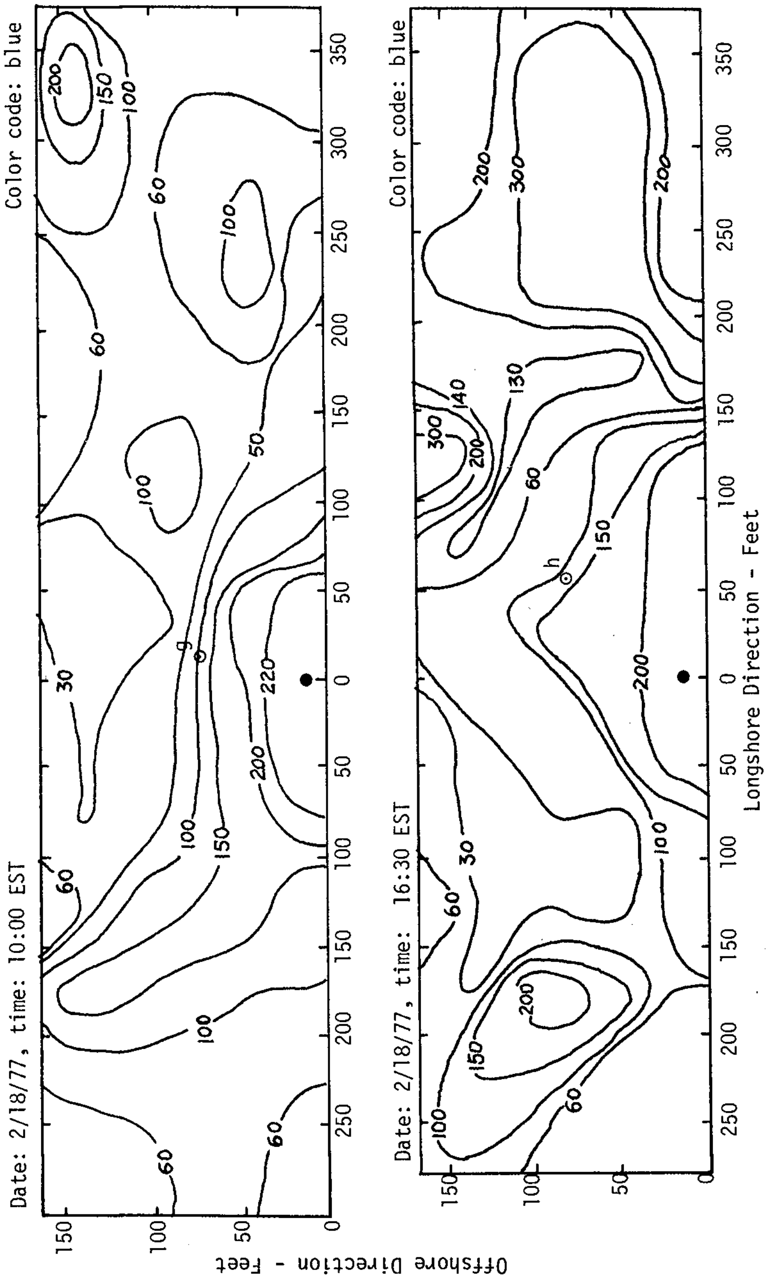

Figure 3. g and h, Equal Concentration Contour Maps

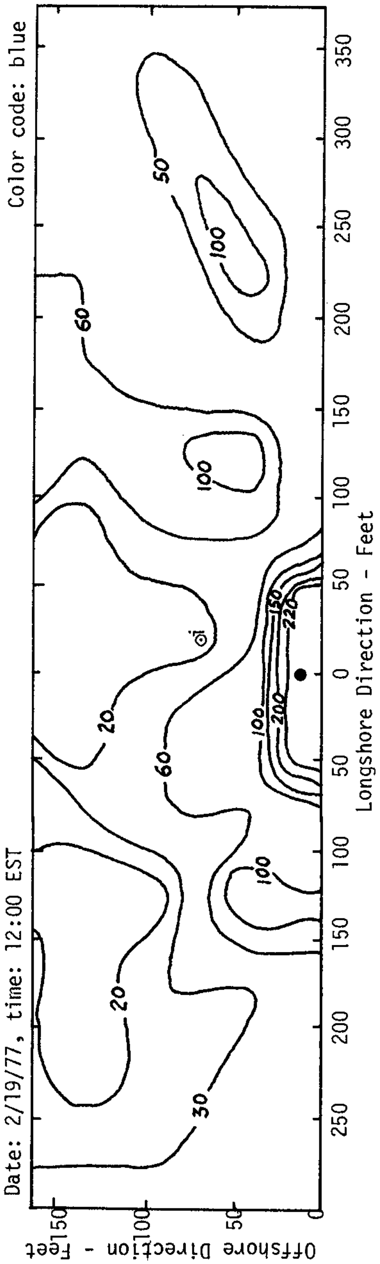

Figure 3. i, Equal Concentration Contour Maps

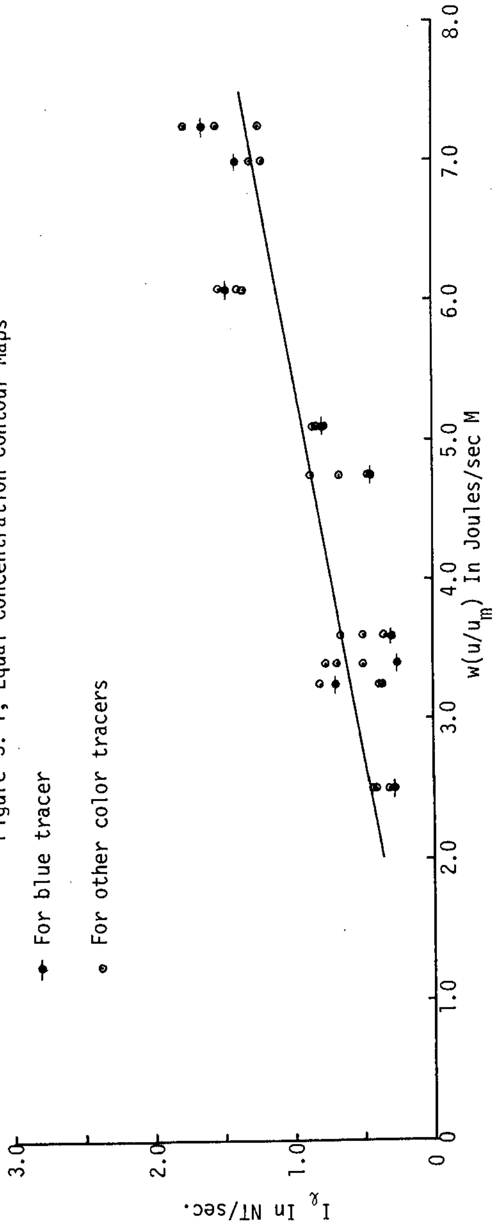

Figure 4. I_ℓ Versus $w(u/u_m)$

DISCUSSION OF RESULTS

1. The calculated regressional coefficient K' = 0.18 is approximately 36% smaller than the value 0.28 for open coast given by Komar in 1969.

2. There are, in general, two difficulties involved in a sand-tracing operation. First, the conservation of the tracer within the sampling area is often violated due to (a) loss of tracer seaward of the surf zone, (b) tracer moving out of the sampling area and (c) tracer loss due to burials. Secondly, the determination of the active moving layer depth and its vertical variations are uncertain. However, these were not the problems in the present study. Following a single injection of 100 pounds each of the four colors of fluorescent tracer; there were nine consecutive sampling operations covering a time span of five days. The nine equal concentration contour maps of the blue tracer (the other 3 colors as well) have shown that much of the tracers remain in the sampling region after 5 days. The depth of active moving sand layer on the bayshore was small (1/8 inch), and therefore there was very little or no loss of tracer due to burial.

3. The tide and wind induced currents were taken care of by using Bagnold's formula for sediment transport rate calculations.

4. The tracer dispersal pattern was characterized by closed loops and islands in the equal concentration contour maps. These peaks and valleys on the maps correspond to the bathymetry configurations. The low transverse bar tends to collect tracer on its troughs and less tracer on its broad crests (Wang et al, 1977).

5. The concentration of tracers in the injection area were noticably increased in Figure 3. i, from the previous contour map. This indicated a strong onshore movement which may have been induced by an onshore wind-driven current.

6. All nine centroids of equal concentration contour maps were collected and plotted in Figure 5. The centroids are marked with letters which correspond to the sequence of the contour maps in Figure 3. A study of the movement of these centroids revealed the following interesting observations.

(a) The tracers were injected 25 feet from the water's edge (see Figure 3). Four hours after the injection the centroid #a moved out a distance approximately 80 feet from the water's edge.

(b) Several reversals of the drift direction during the five day period were clearly observable. The sand transport was longshore dominant. The on/off shore transport was relatively small compared to their longshore component.

(c) All nine centroids were in the region approximately 65 to 80 feet from the water's edge. This peculiar character may be explained by the fact that the coating of the local sand with fluorescent dye resulted in an increase of sand particle volume, consequently, a decrease of the specific gravity. When tracers were injected back in to the shoreline they were subjected to a wave-sorting process and moved bayward

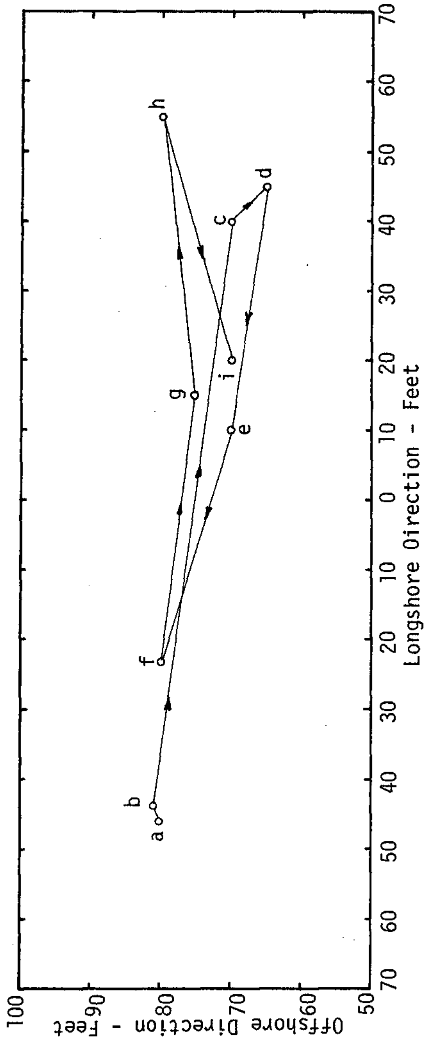

Figure 5. A Collection Of The Centroids From Figure 3

because the tracers were lighter than the local sand at the injection point. This may raise a question concerning the accuracy of the convective velocity V defined in equation (2). Perhaps the distance between the injection point and the centroid of the first contour map should be adjusted to account for the wave sorting effect. It is however not clear how one can perform this adjustment properly.

ACKNOWLEDGEMENT

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