SITE SELECTION STUDY FOR A MAJOR TRAP EXPERIMENT: ATLANTIC COAST OF THE UNITED STATES

by

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INTRODUCTION

The purpose of this report is to evaluate east coast sites as candidates for a major sediment trap experiment. In addition to twelve east coast sites, one site in the Gulf of Mexico was included. The objective of the trap experiment is, through measurement of the sediment accumulated in the trap and the wave characteristics causing the sand transport, to develop data that will contribute to the quantitative understanding of sediment transport by waves. A particular objective is the development and/or verification of an engineering relationship between longshore sediment transport and wave characteristics.

The objectives of this report parallel those of Reference 1 in which a search for a west coast site evaluated the Channel Islands Harbor and Santa Barbara Harbor areas in some detail. That study concluded by recommending the Santa Barbara Harbor site in large part due to the perceived relative lack of bias on the impounded volumes due to the breakwater/channel system which forms the trap.

The factors to be considered in the site selection include 1) the geomorphic characteristics of the shoreline with emphasis on the representability of the area, 2) the wave characteristics with interest in the wave climate being reasonably unidirectional for the first site, but with less weight on this factor for the second site selected, and 3) the inherent logistics of the area which include accessibility to the beach, other activities or support at the site which would strongly complement the study, etc.

One significant difference between the west and east coast sites is that on the west coast, there are structures in areas of nearly unidirectional drift that appear to perform as complete littoral barriers. Although there are many jettied channel entrances on the east coast including two at which fixed sand bypassing plants are located, for a variety of reasons none of these were considered appropriate for the east coast site. Therefore it appears most advantageous to construct an appropriate structure to represent an essentially complete barrier to the littoral transport system and which can be adjusted to be essentially "transparent" to the waves so that the beach can equilibrate.

DESIRABLE CHARACTERISTICS OF SITE

There are a number of desirable characteristics which should be present at a site for a littoral trap experiment. These are presented briefly below; a more extensive discussion is available in Reference 1.

Beach Geomorphology

The beach planform and profile geometry should be fairly simple and representative of beaches on the east coast of the United States. Undesirable features would include: accentuated planform features, such as rhythmic topography, short beach segments interrupted by inlets, an unusual presence of rip currents, offshore rock or mud reefs, and poorly sorted sediments. Additionally, the beach sized sand should be present in a layer of sufficient thickness that a storm profile would not result in exposure of material of substantially different transport or erodibility characteristics.

Wave Characteristics

Ideally, the waves should be of such a magnitude that by selecting the weather properly, working in the surf zone is feasible. Also, the waves should be of fairly simple directional characteristics with not too great a variability. In particular, if a barrier is placed across the surf zone, there should be a reasonably good probability of the transport remaining in the same direction for a sufficiently long duration to result in a measurable amount of sediment transport and deposition in the trap.

Trap Characteristics

The desirable trap characteristics have been discussed extensively in Reference 1. It is sufficient to note here that ideally the trap should perform in a "passive" mode. That is, it should trap and store the net longshore transport within a limited and known area without biasing the transport characteristics. No trap will behave in a truly ideal manner; therefore, it should be possible to place estimates on the magnitude of the transport bias caused by the trap.

Logistics

The desirable logistical characteristics are fairly self-explanatory. Included are: the availability of power, the ability to house shore instrumentation in a secure area, and a site which is readily accessible by major air routes and highways. Any research or other generally supportive activities or available equipment or facilities at a site could be extremely valuable to the trap experiment.

WAVE CLIMATOLOGY

As noted, the direction and height characteristics of waves are important in the assessment of a site. Although the emphasis on highly directional transport has been relaxed relative to the west coast site, it is still important that the net longshore transport be a substantial percentage of the gross transport, ideally greater than 50%.

Sources of Wave Data

There are several sources of wave data available, some of which have been interpreted previously in terms of longshore sediment transport characteristics. The observations of waves from ships organized as a portion of tabulations entitled "Summary of Synoptic Meteorological Observations" (SSMO) currently represents the most universally available wave data. These data are available on magnetic tape from the National Weather Service as Tape Data Family-11 (TDF-11). Studies underway at the Waterways Experiment Station entitled Wave Information Study (WIS) are currently in a state of finalization for the east coast and may soon supplant the SSMO data for longshore sediment transport calculations and coastal engineering design. The Littoral Environmental Observation (LEO) program carried out by the Coastal Engineering Research Center (CERC) includes periodic observations of breaking wave heights, periods and directions by shore-based observers at selected locations along the coastline of the United States. Walton (1976) has utilized the SSMO data to develop average monthly "Littoral Drift Roses" along the entire sandy shoreline segments of Florida. These roses present a great deal of longshore transport information in a very compact form.

The methodology for utilizing SSMO data to calculate longshore sediment transport has been presented previously in Reference 1 (p. 47-52) and will not be repeated here. The LEO data represent wave conditions at breaking and are based on the same procedures referenced above, except for these data it is not necessary to transform the waves from deep to shallow water. Three additional points are worth mentioning. First, the sign convention used for longshore sediment transport is "positive to the right" as a shore-based observer looks seaward. Secondly, the longshore sediment transport values presented here all use the common constant K = 0.77 (Komar and Inman, 1970) relating immersed weight sediment transport rate to longshore energy flux at breaking. Finally, where available data permitted, a normalized index of variability, ε, was calculated for wave and transport conditions as follows

$$\varepsilon = \sqrt{\frac{\sum_i (\beta_i - \overline{\beta})^2}{\sum_i \beta_i^2}}$$

where β is the quantity whose variability is under question, the subscript i refers to the ith observation, and an overbar is used to indicate the statistical mean of the quantity. In the case of extreme variability relative to the mean, ε approaches unity and if β is absolutely steady, ε is zero.

SITES CONSIDERED AND RESULTS

This site selection study commenced with considerations of areas having suitable shoreline morphology, reasonable year-round working conditions on the beach and an existing trap capability. No suitable traps were located and this screening resulted in the remainder of the study concentrating on the region from Assateague Island, Maryland to Eglin Air Force Base, Florida. Due to the presence of the CERC Field Research Facility (FRF) at Duck, North Carolina, this area was included in the sites considered. Since waves and longshore sediment transport characteristics are relevant to the site selection, some of the sites reported here were examined due to the availability of LEO data with the presumption that the results would apply over a reasonably long segment of the shoreline if the alignment did not change substantially. Figure 1 portrays the sites examined and Table 1 presents the relevant wave, tide and longshore sediment transport characteristics and the source of the basic wave data. The relevant features of each of these sites are discussed below with special emphasis on the Duck, NC and Eglin Air Force Base, FL sites as they are the recommended two alternates.

Assateague Island, MD

The average monthly longshore sediment transport characteristics as based on LEO data are presented in Figure 2 and Table 2. The average annual net longshore sediment transport is approximately 215,000 m^3 with a ratio of average net to gross transport of 0.43. The dominant transport is toward the south during the fall and winter months and there are two months during which transport reversals occur and one month where the transport is nearly balanced.

Duck, NC

This is the site of the CERC Field Research Facility (FRF). This facility consists of a 550 m long pier situated approximately midway along an 1800 m beach segment dedicated to coastal engineering research. Much of the information presented has been provided by CERC and this assistance is greatly appreciated. There are two sources of wave data available for Duck (SSMO and LEO) and since the Avalon Pier and Sea Crest locations are within 16 kilometers, these wave data (LEO) are also considered to apply to Duck.

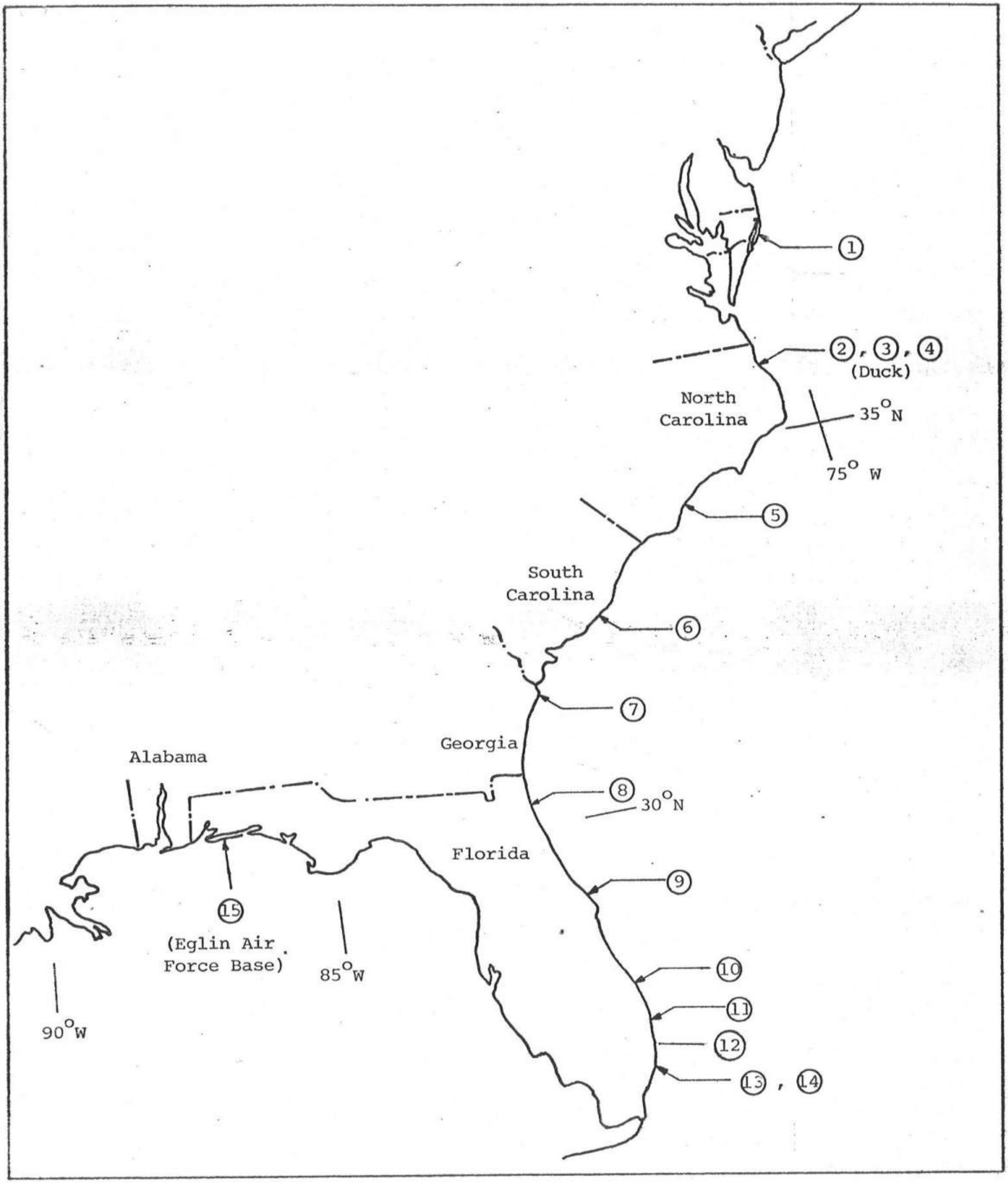


Figure 1. Locations of Various Sites Evaluated. Circled Numbers Refer to Entries in Table 1.

TABLE 1

SUMMARY OF LONGSHORE SEDIMENT TRANSPORT AND OTHER RELEVANT CHARACTERISTICS AT LOCATIONS CONSIDERED

Site Designation	Approximate Latitude (or Longitude)	Tidal Range (m) Mean/Spring	Source of Wave or Sed. Transport Information	Annual Longshore Sediment Transport Characteristics			Average Annual Breaking Wave Height, (m)	Approximate Average Sediment Size, (mm)
				Q_N (m^3/yr.)	Q_G (m^3/yr.)	Q_N/Q_G		
1. Assateague Is., MD	38° 03'N	1.04/1.25	LEO (CERC)	215,200	498,900	0.43	0.64	0.20
2. Duck, NC	36° 11'N	0.98/1.16	TDF-11 (NOAA) LEO (CERC)	104,000 39,420	187,000 506,560	0.56 0.08	0.61 0.73	0.40
3. Avalon Pier, NC	36° 02'N	0.98/1.16	LEO (CERC)	117,500	269,900	0.44	0.53	0.40
4. Sea Crest, NC	36° 07.5'N	0.98/1.16	LEO (CERC)	189,200	440,500	0.43	0.82	0.40
5. Holden Beach, NC	33° 54.5'N	1.46/1.55	TDF-11 (NOAA)	32,100	58,400	0.55	0.72	0.30
6. Bull Is., SC*	32° 53.8'N	1.70/1.85	LEO (CERC)	185,000	346,300	0.53	0.65	0.30
7. Tybee, Is., GA	32° 02'N	2.10/2.47	LEO (CERC)	276,850	744,400	0.37	0.73	0.40
8. Jacksonville Beach, FL	30° 15'N	1.37/1.62	Walton	458,000	1,360,000	0.34	0.58	0.30

*Average of Stations 1 and 2.

TABLE 1
(Continued)
SUMMARY OF LONGSHORE SEDIMENT TRANSPORT AND OTHER RELEVANT CHARACTERISTICS AT LOCATIONS CONSIDERED

Site Designation	Approximate Latitute (or Longitude)	Tidal Range (m) Mean/Spring	Source of Wave or Sed. Transport Information	Annual Longshore Sediment Transport Characteristics			Average Annual Breaking Wave Height, (m)	Approximate Average Sediment Size, (mm)
				Q_N (m^3/yr.)	Q_G (m^3/yr.)	Q_N/Q_G		
9. No. of Cape Kennedy, FL	28^o 40'N	1.07/1.25	Walton	27,000	1,056,000	0.03	0.67	0.50
10. Hutchinson Is., FL	27^o 18'N	0.79/0.91	Walton	300,000	1,036,000	0.29	0.70	0.30
11. Palm Beach Is., FL	26^o 36'N	0.85/1.01	Walton	336,000	1,072,000	0.31	0.70	0.30
12. Boca Raton, FL	26^o 20'N	0.76/0.91	Walton	460,000	1,092,000	0.42	0.63	0.50
13. Indian Beach Park, FL	25^o 51'N	0.76/0.91	LEO (CERC)	10,100	171,930	0.06	0.29	0.50
14. Lummus Park, FL	25^o 46'N	0.76/0.91	LEO (CERC)	11.500	272,286	0.51	0.33	0.40
15. Eglin Air Force Base, FL	(86^o 45'W)	----/0.34*	Walton	444,000	824,000	0.54		0.45

*Diurnal Tide

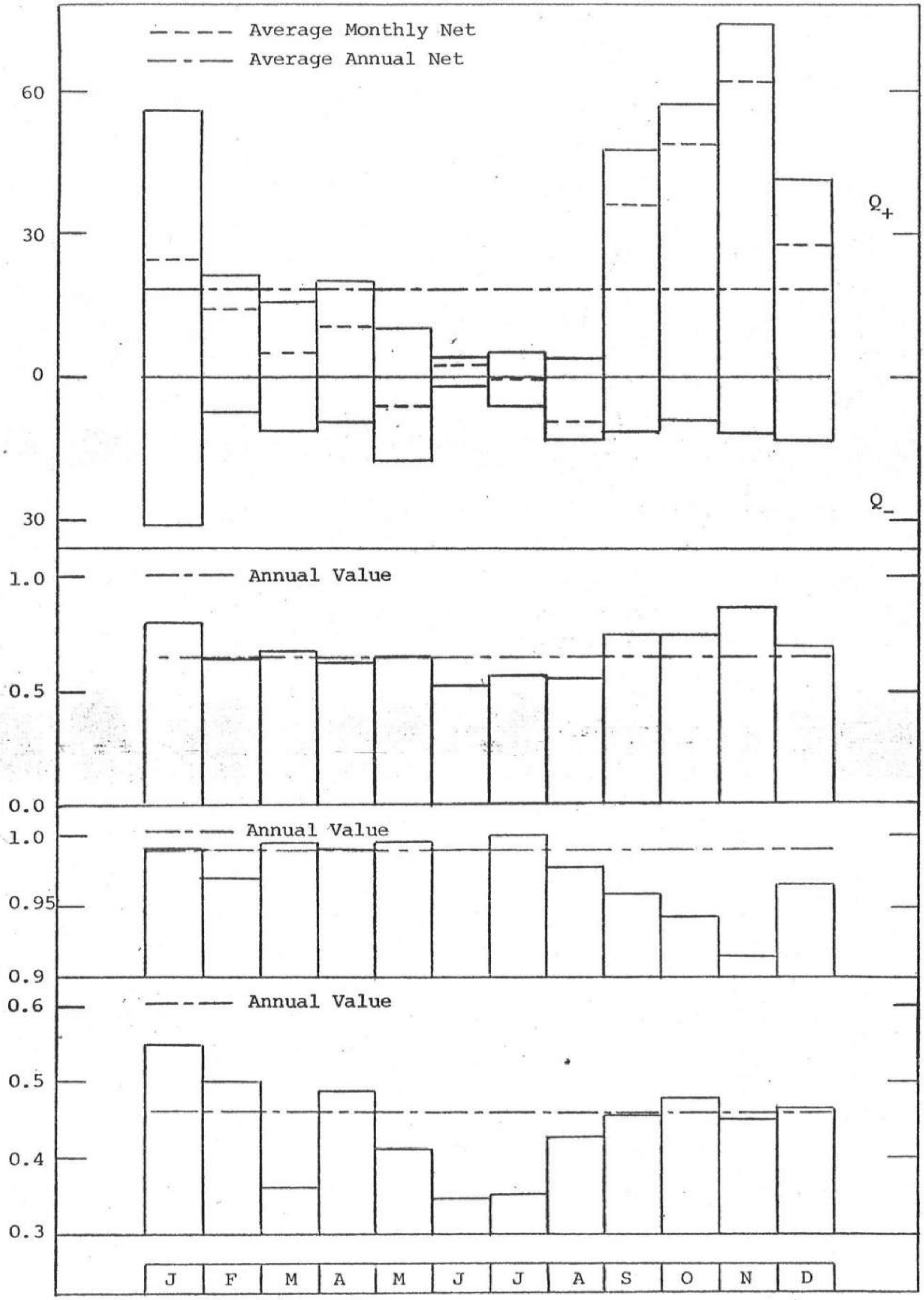


Figure 2. Longshore Transport and Breaking Wave Height Characteristics for Assateague Island, MD.

TABLE 2

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR ASSATEAGUE ISLAND, MD
(Based on LEO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	55,829	30,835	86,664	24,994	28.8
F	21,288	7,225	28,513	14,063	49.3
M	16,054	10,955	27,009	5,099	18.9
A	20,282	9,421	29,703	10,861	36.6
M	10,821	16,942	27,763	-6,121	22.0
J	3,890	1,767	5,657	2,123	37.5
J	4,956	5,971	10,926	-1,015	9.3
A	3,901	13,696	17,597	-9,795	55.7
S	46,943	10,856	57,799	36,087	62.4
O	57,460	8,967	66,427	48,493	73.0
N	74,375	11,907	86,282	62,468	72.4
D	41,212	13,298	54,510	27,914	51.2
ANNUAL (m^3/yr)	357,011	141,840	498,851	215,171	43.1
ANNUAL AVERAGE (m^3/mo)	29,751	11,820	41,571	17,931	43.1

Available Leo Data

Year	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
1971		2	2	1								
1972						6	30	27				
1977		8	31	30	31	28	33	31	30	31	30	29
1978	31	28	31	30	31	30	31	31	27	28		

Total of 666 Data Points Over Four Years.

Longshore Sediment Transport - There is considerable question regarding the character of the longshore sediment transport at this site.

The longshore sediment transport and wave characteristics as determined from the ship observations are presented in Figure 3 and Table 3. The calculated annual net and gross longshore transport values are 104,000 and 187,000 m^3/yr. with a ratio of net to gross transport of 0.56. The two years of LEO data at Duck (November 1977 to October 1979) yield corresponding values of 39,400 and 507,000 m^3/yr. for a ratio of 0.08. These results are presented in Figure 4 and Table 4. As presented in Figure 5 and Table 5, the annual net and gross transport values for Sea Crest, NC are 189,000 and 441,000 m^3/yr. respectively for a ratio of 0.43. Finally the corresponding values for Avalon Pier are 117,500 m^3/yr., 269,900 m^3/yr. and 0.44, see Figure 6 and Table 6. It should be noted that the transport quantities calculated from the two years of LEO data at Duck, NC were markedly different and if only the second year (November 1978 to October 1979) is used, the net value (88,000 m^3/yr.) is in better agreement with the SSMO quantity; however, the gross transport value (604,752 m^3/yr.) still differs somewhat. Although the estimates of longshore sediment transport quantities differ considerably, it appears that reasonably representative long-term average annual quantities are 110,000-150,000 m^3/yr. for the net longshore transport and 250,000-400,000 m^3/yr. for the gross longshore transport.

Sediment Characteristics - The sediment characteristics along the northern outer banks of North Carolina have been studied by Headland and DeWall (undated) and were made available in draft manuscript form. The sediment size ranges from approximately 0.35 mm in the dunes to 0.80 mm in the beach face area to approximately 0.15 mm at the 15 m contour. During a visit to the FRF in June 1979, it was noticed that there appeared to be two distinct types and,

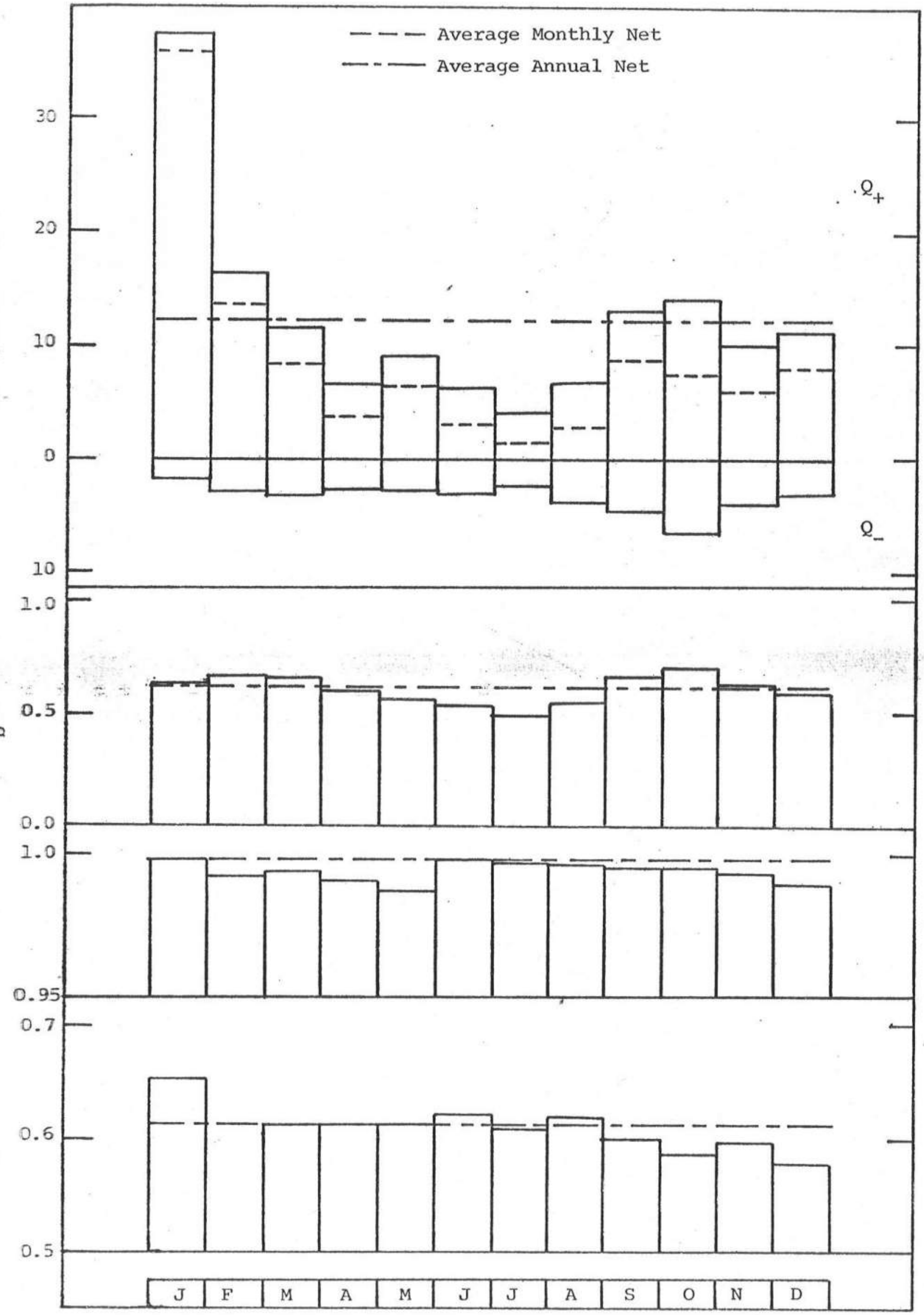


Figure 3. Longshore Transport and Breaking Wave Height Characteristics for Duck, NC.

TABLE 3

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR DUCK, NC
(Based on SSMO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	37,719	1,801	39,520	+35,918	90.9
F	16,260	2,803	19,063	+13,457	70.6
M	11,614	3,135	14,749	+ 8,479	57.5
A	6,555	2,828	9,383	+ 3,727	39.7
M	9,052	2,941	11,993	+ 6,111	51.0
J	5,608	3,051	8,659	+ 2,557	29.5
J	4,026	2,623	6,649	+ 1,403	21.1
A	6,452	3,612	10,064	+ 2,840	28.2
S	13,194	4,743	17,937	+ 8,451	47.1
O	14,061	6,708	20,769	+ 7,353	35.6
N	9,993	4,134	14,127	+ 5,859	41.5
D	11,354	3,272	14,626	+ 8,081	55.3
ANNUAL (m^3/yr.)	145,888	41,651	187,539	104,237	55.6
ANNUAL AVERAGE (m^3/mo.)	12,157	3,471	15,628	8,686	55.6

Total of 19,233 SSMO Data Points.

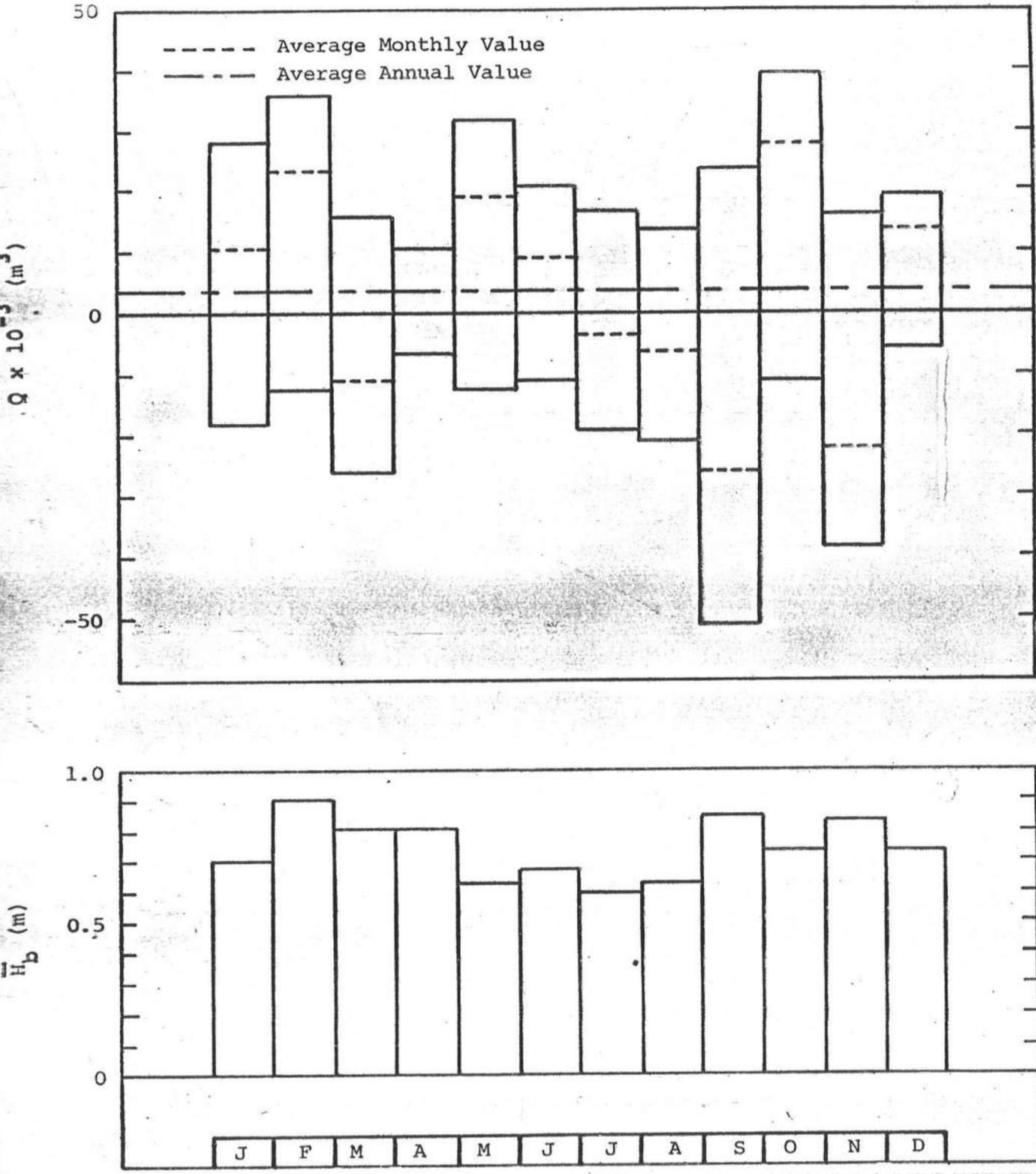


Figure 4. Longshore Sediment Transport and Breaking Wave Characteristics for Duck, NC. Based on LEO Data.

TABLE 4

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR DUCK, NC
(Based on LEO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	28,400	18,050	46,450	10,350	22.3
F	36,020	12,620	48,640	23,400	48.1
M	15,360	26,430	41,790	-11,070	-26.5
A	11,110	6,850	17,960	4,260	23.7
M	31,780	12,060	43,840	19,720	45.0
J	20,700	10,990	31,690	9,710	30.6
J	17,010	19,870	36,880	- 2,860	- 7.8
A	13,910	20,490	34,400	- 6,580	-19.1
S	23,950	50,910	74,860	-26,960	-36.0
O	39,110	11,430	50,540	27,680	54.8
N	16,050	38,430	54,480	-22,380	-41.1
D	19,590	5,440	25,030	14,150	56.5
ANNUAL (m^3/yr)	272,2990	233,570	506,560	39,420	7.8
AVERAGE ANNUAL (m^3/mo)	22,750	19,460	42,213	3,290	7.8

Available Leo Data

Year	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
1977											16	21
1978	21	18	22	18	20	18	19	20	21	20	18	19
1979	23	16	20	19	20	18	21	21	19	21		

Total of 469 Data Points Over Three Years.

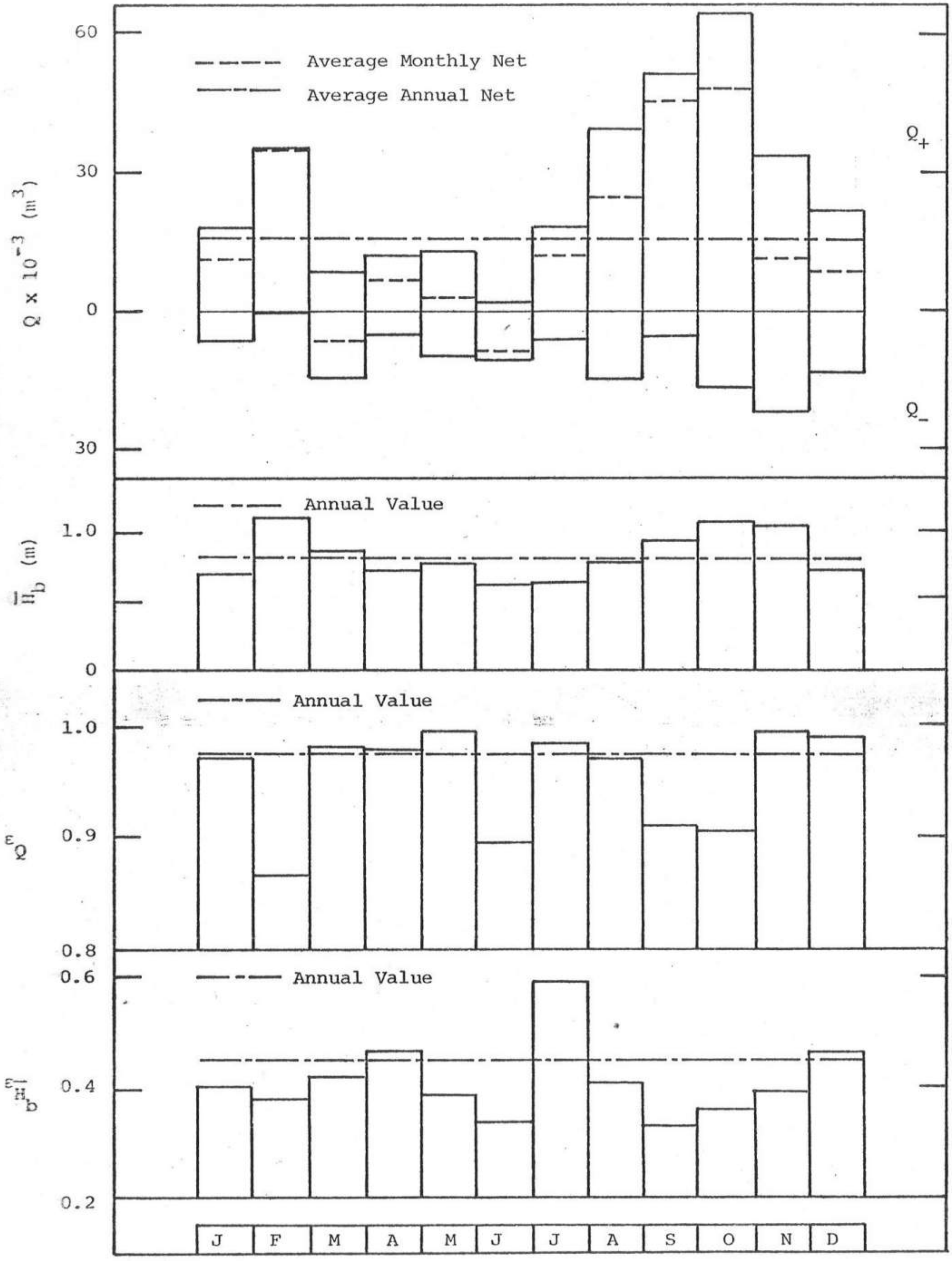


Figure 5. Longshore Transport and Breaking Wave Height Characteristics for Sea Crest, NC.

TABLE 5

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR SEA CREST, NC
(Based on SSMO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	17,622	6,280	23,902	11,342	47.5
F	35,086	320	35,406	34,766	98.2
M	8,165	14,652	22,817	-6,487	28.4
A	12,014	5.114	17,128	6,900	40.3
M	12,735	9,626	22,361	3,109	13.9
J	1,801	10,835	12,636	-9,034	71.5
J	17,754	6,133	23,887	11,621	48.6
A	39,126	15.093	54,219	24,034	44.3
S	51,368	6,354	57,722	45,014	78.0
O	64,533	16,465	80,998	46,068	59.3
N	32,854	21,878	54,732	10,976	20.1
D	21,772	12,881	34,653	8,891	25.7
ANNUAL (m^3/yr)	314,830	125,631	440,641	189,199	43.0
AVERAGE ANNUAL (m^3/mo)	26,236	10,469	36,705	15,767	43.0

Available Leo Data

	Month											
Year	J	F	M	A	M	J	J	A	S	O	N	D
1972							36	29	30	34	39	43
1974	27											
1977	31	4	9	11	26	28	30	30	30	14	7	4
1978	20	27	14	18	11	17	11					

Total of 589 Data Points Over Four Years.

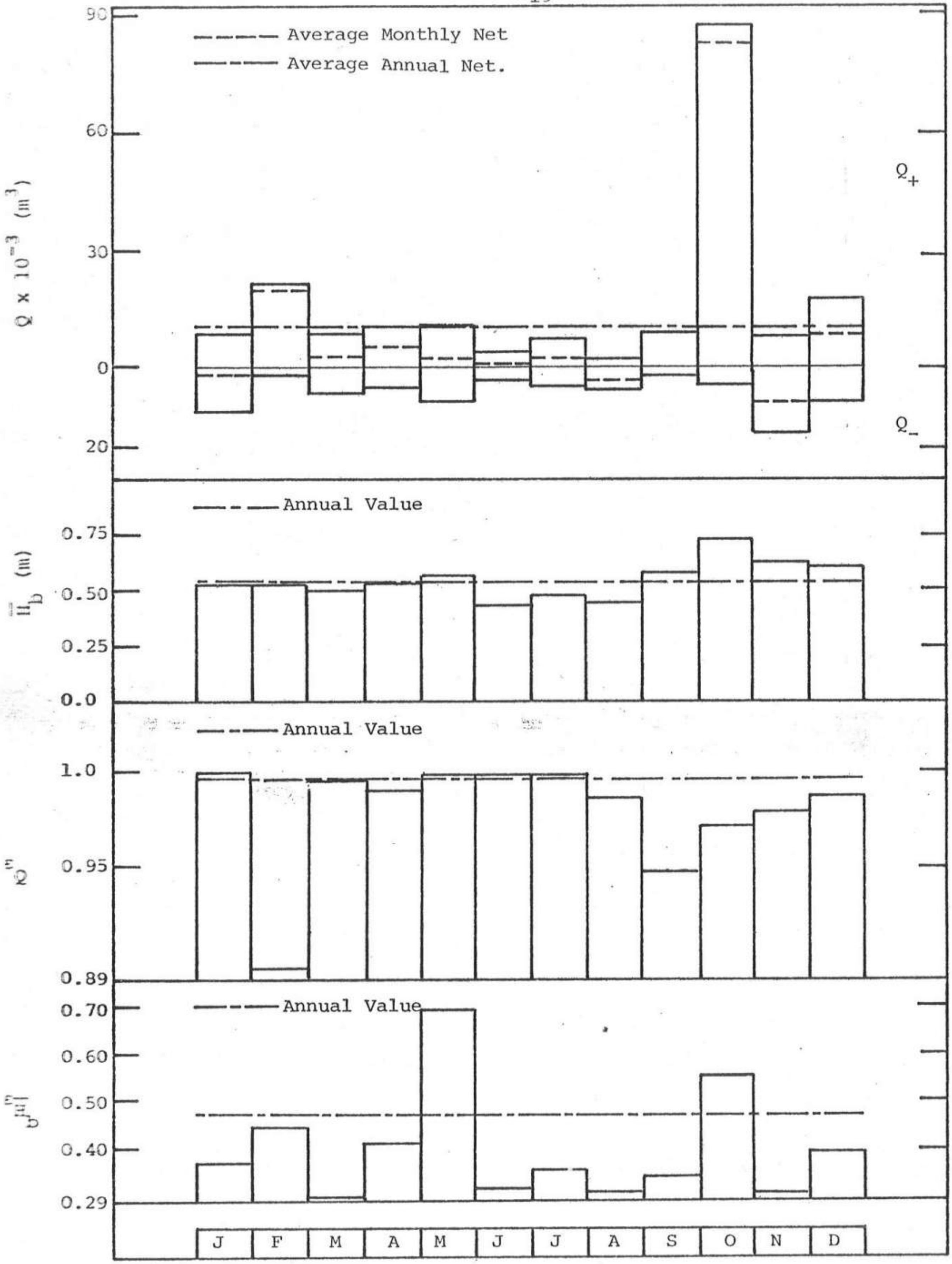


Figure 6. Longshore Transport and Breaking Wave Height Characteristics for Avalon Pier, NC.

TABLE 6

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR AVALON PIER, NC
(Based on LEO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	9,120	10,907	20,027	-1,787	8.9
F	21,200	1,137	22,337	20.063	89.8
M	8,563	6,187	14,750	2,376	16.1
A	10,486	5,072	15,558	5,414	34.8
M	10,621	8,034	18,655	2,587	13.9
J	4,025	2,929	6,954	1.096	15.8
J	7,168	4,783	11,951	2,385	20.0
A	2,111	5,344	7,455	-3,233	43.4
S	9,127	1,411	10,538	7,716	73.2
O	86,300	4,594	90,894	81,706	89.9
N	7,687	17,322	25,009	-9,635	38.5
D	17,285	8,464	25,749	8,821	34.3
ANNUAL (m^3/yr)	193,693	76,184	269,877	117,509	43.5
AVERAGE ANNUAL (m^3/mo)	16,141	6,349	22,490	9,792	43.5

Available Leo Data

Year	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
1977		18	62	28	34	63	62	62	58	63	48	31
1978	31	28	31	31	31	30	31	31				

Total of 773 Data Points Over Two Years.

therefore, sources of sediment. Although not definite, one type appeared to be well sorted beach sand whereas the other type was coarser and appeared to be the result of erosion into material that had not been subjected much to wave action. The relative amounts of the two types is, at present, unknown. Based on visual impressions, the material on the dry beach was dominantly the well-sorted finer material.

Wave Characteristics - Based on both the SSMO and LEO data, there is not much variation in the mean monthly wave height. See Figures 3, 4, 5 and 6 for the variation in the mean monthly wave height and the variability coefficient $\varepsilon_{\overline{H}_b}$ as based on the SSMO data. The mean annual wave heights as based on SSMO and LEO data at the Duck site are 0.61 m and 0.73 m respectively. The mean annual wave period based on the LEO data is 9.50 sec.

Underwater Visibility - Underwater near-bottom visibility at the Duck site appears to be extremely limited during most months of the year.

Holden Beach, NC

This site is located along a beach segment trending northeast-southwest. The longshore sediment transport characteristics as determined from SSMO data are presented in Figure 7 and Table 7. It is seen that the longshore sediment transport quantities are much smaller than those near the Duck site.

Bull Island, SC

The wave and longshore sediment transport characteristics are based on the averages of data obtained from two LEO stations and are presented in Figure 8 and Table 8. The wave and sediment transport characteristics were calculated at this site because reasonably good LEO data are available and it does provide continuity from north to south. However, Bull Island is considered to be too short for a trap experiment.

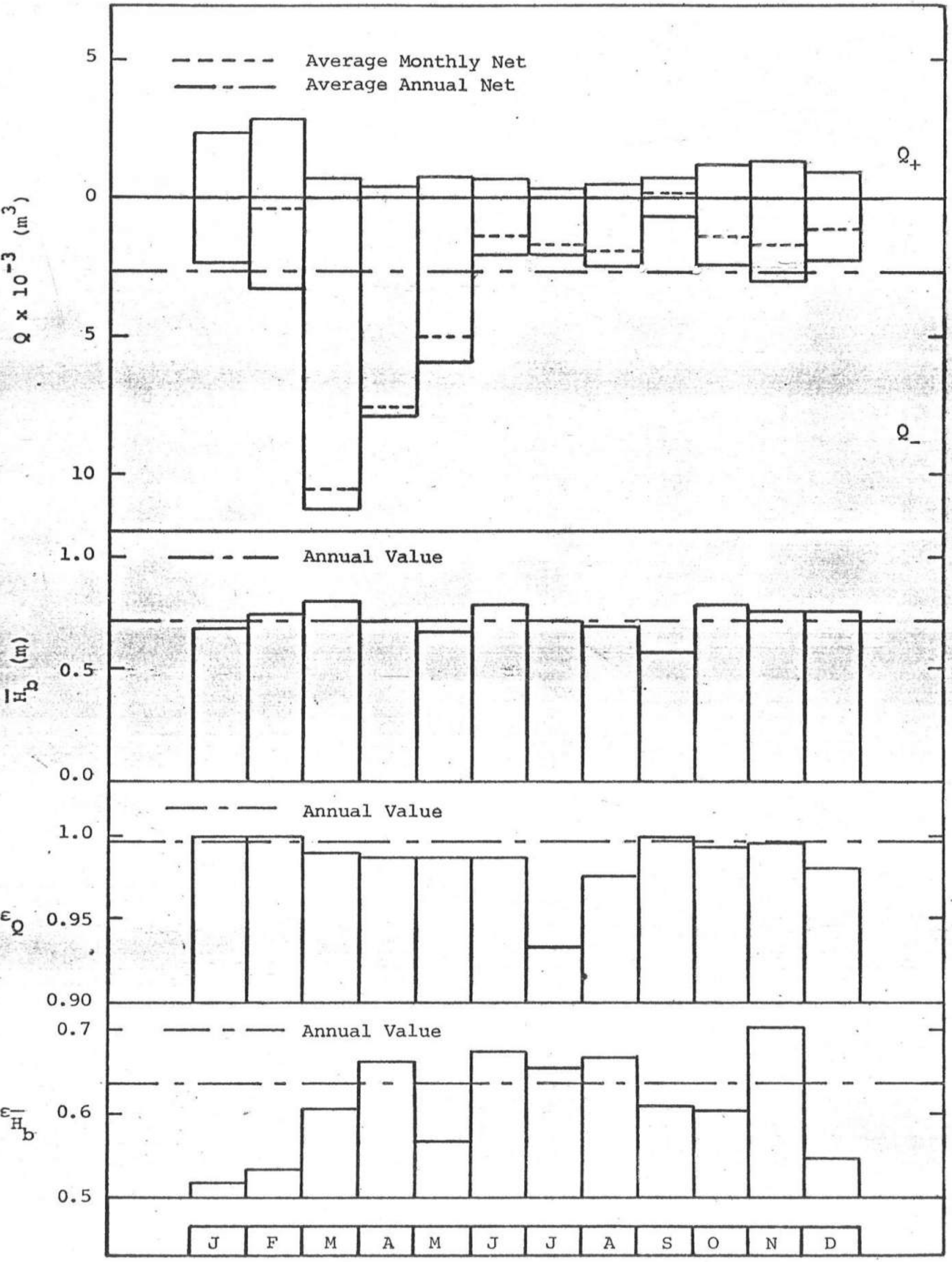


Figure 7. Longshore Transport and Breaking Wave Height Characteristics For Holden Beach, NC.

TABLE 7

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR HOLDEN BEACH, NC
(Based on SSMO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	2,382	2,394	4,776	- 12	- 0.3
F	2,831	3,265	6,096	- 433	- 7.1
M	779	11,232	12.011	-10,453	-87.0
A	425	7,928	8,353	- 7,503	-89.8
M	843	5,902	6,745	- 5,059	-75.0
J	712	2,054	2,766	- 1,342	-48.5
J	417	2,044	2,461	- 1,627	-66.1
A	522	2,347	2,869	- 1,825	-63.6
S	716	628	1,344	88	6.5
O	1,224	2,419	3,643	- 1,195	-32.8
N	1,338	2,940	4,278	- 1,602	-37.4
D	958	2,075	3.033	- 1,117	-36.8
ANNUAL (m^3/yr)	13,147	45,228	58,375	-32,081	-55.0
AVERAGE ANNUAL (m^3/mo)	1,096	3,769	4,865	- 2,673	-55.0

Available SSMO Data

Month											
J	F	M	A	M	J	J	A	S	O	N	D
63	59	80	114	128	134	174	197	112	68	75	62

Total of 1266 Data Points.

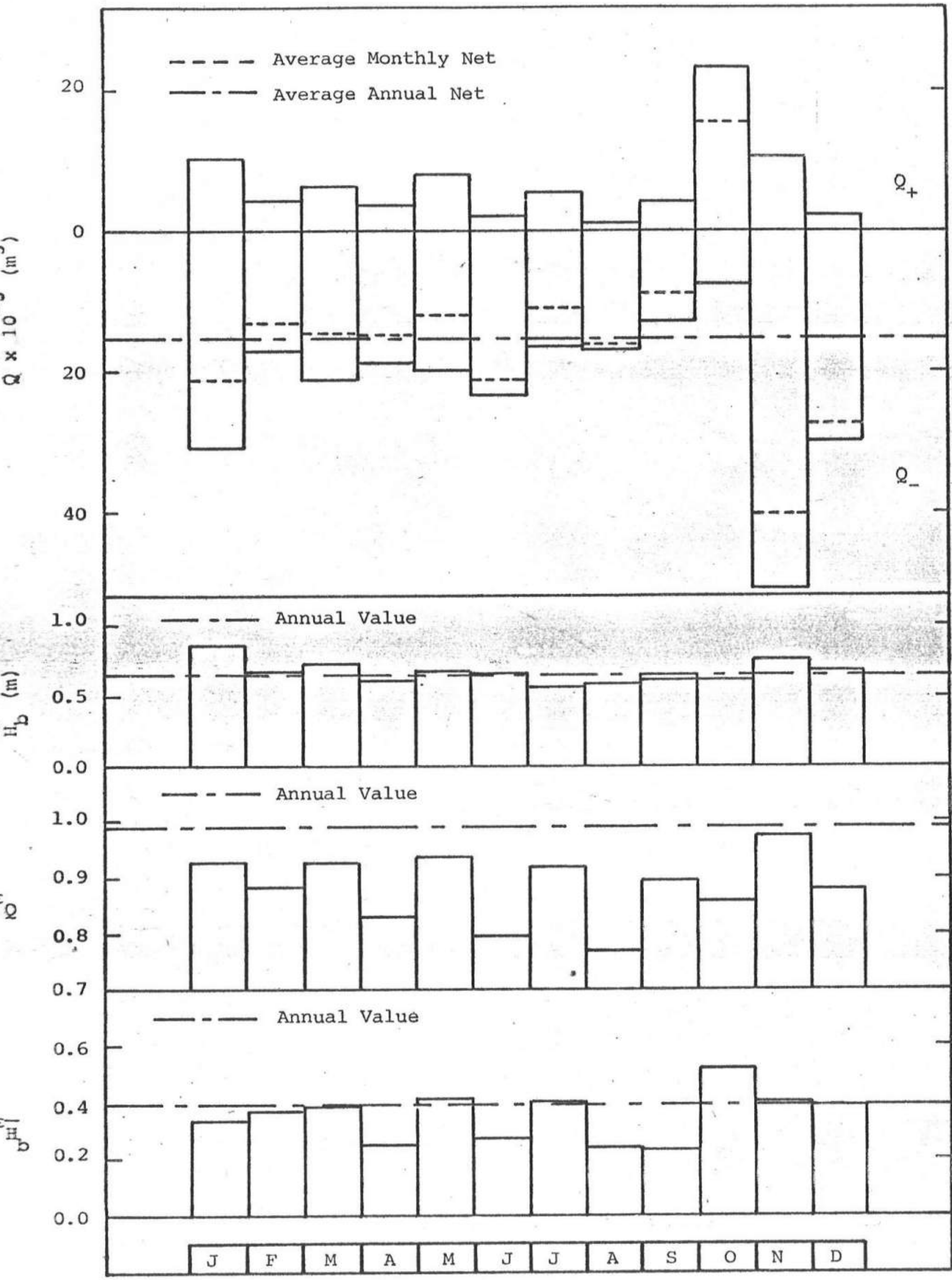


Figure 8. Longshore Transport and Breaking Wave Height Characteristics for Bull Island, SC.

TABLE 8

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR BULL ISLAND, GA
(Based on LEO Data-Averages of Stations 1 and 2 on Bull Island)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	10,355	31,143	41,498	-20,788	-50.1
F	4,245	17,211	21,456	-12,966	-60.4
M	6,440	21,090	27,530	-14,650	-53.2
A	3,643	18,830	22,473	-15,187	-67.6
M	8,065	19,858	27,923	-11,793	-42.2
J	1,861	23,463	25,324	-21,602	-85.3
J	5,554	16,362	21,916	-10,808	-49.3
A	1,004	16,901	17,905	-15,897	-88.8
S	3,970	12,996	16,966	- 9,026	-53.2
O	23,276	7,716	30,992	15,560	50.2
N	10,451	50,810	61,261	-40,359	-65.9
D	1,772	29,297	31,069	-27,525	-88.6
ANNUAL (m^3/yr)	80,636	265,677	346,313	-185,041	-53.4
AVERAGE ANNUAL (m^3/mo)	6,720	22,140	28,860	-15,420	-53.4

Available LEO Data

Year	Month J	F	M	A	M	J	J	A	S	O	N	D
1977		10 10	25 25	21 21	30 30	25 25	21 21	23 22	18 18	19 19	12 13	20 (1) 22 (2)
1978	10 11	22 22	22 22	13 13	14 14							

( ) = Station Number
Total of 613 Data Points Over Two Years.

Tybee Island, GA

This island is considered too short to be considered as the site for the trap experiment, but was included due to the good quality LEO data and to provide north to south continuity, see Figure 9 and Table 9.

Jacksonville Beach, FL

The longshore sediment transport characteristics at this site, presented in Figure 10 are based on the "littoral drift roses" by Walton. The indicated transport rates are significantly higher than sites examined to the north; the ratio of net to gross transport rate is only 0.34.

North of Cape Kennedy, FL

This site was included because the University of Florida has a field station on the Kennedy Space Center and has maintained an offshore wave pressure sensor for several years. Additionally, access to the beach is reasonably limited and there is probably the possibility of other logistical advantages, including dormitory facilities. The net longshore transport (Figure 11) is considered too small for a trap experiment unless the trap was operated during very selected periods when nearly unidirectional transport prevails. The calculated ratio of net to gross transport is only 0.03.

Hutchinson Island, FL

The longshore transport characteristics at this site include reversals during the summer months and fairly large magnitudes of both net and gross transport values, see Figure 12. The ratio of net to gross is 0.29 which is not considered optimal for a trap experiment.

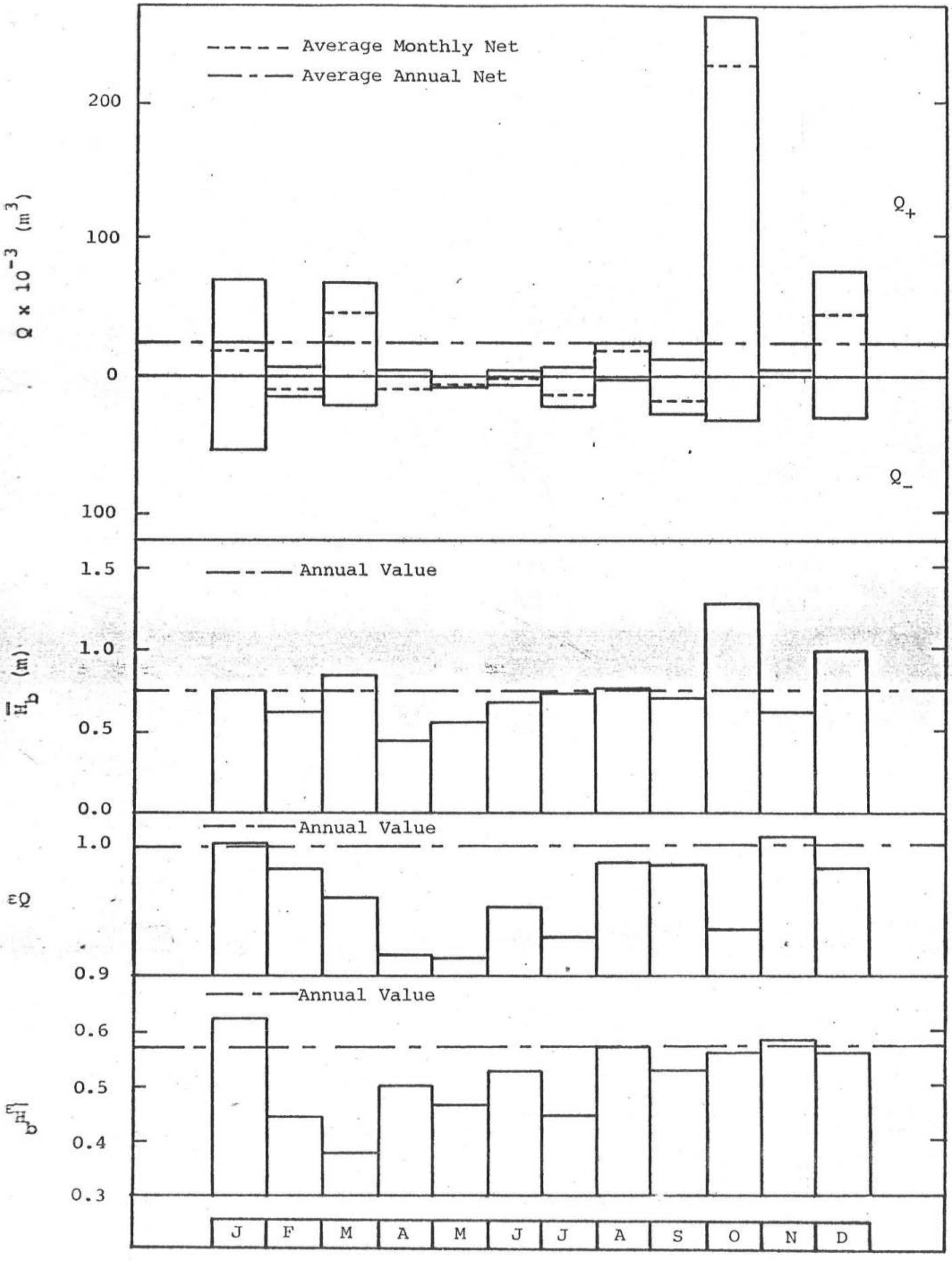


Figure 9. Longshore Transport and Breaking Wave Height Characteristics for Tybee Island, GA.

TABLE 9

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR TYBEE ISLAND, GA
(Based on LEO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	70,585	55,194	125,779	15,391	12.2
F	4,653	13,881	18,534	-9,228	-49.8
M	67,679	22,916	90,595	44,763	49.4
A	2,041	12,611	14,652	-10,570	-72.1
M	992	6,662	7,654	-5,670	-74.1
J	1.986	8,177	10,163	-6,191	-60.9
J	4,768	21,444	26,212	-16,676	-63.6
A	21,973	5,896	27,869	16,077	57.7
S	9,400	29,994	39,394	-20,594	-52.3
O	262,035	36,201	298,236	225,834	75.7
N	3,383	3,305	6,688	78	1.2
D	76,139	32,511	108,650	43,628	40.2
ANNUAL (m^3/yr)	525,635	248,791	774,426	276,844	35.7
AVERAGE ANNUAL (m^3/mo)	43,803	20,733	64,536	23,070	35.7

Available LEO Data

Year	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
1976					7	15	19	21	19	19	19	18
1977	14	13	13	9	10							
1978					17	21	19	20	22			

Total of 295 Data Points Over Three Years.

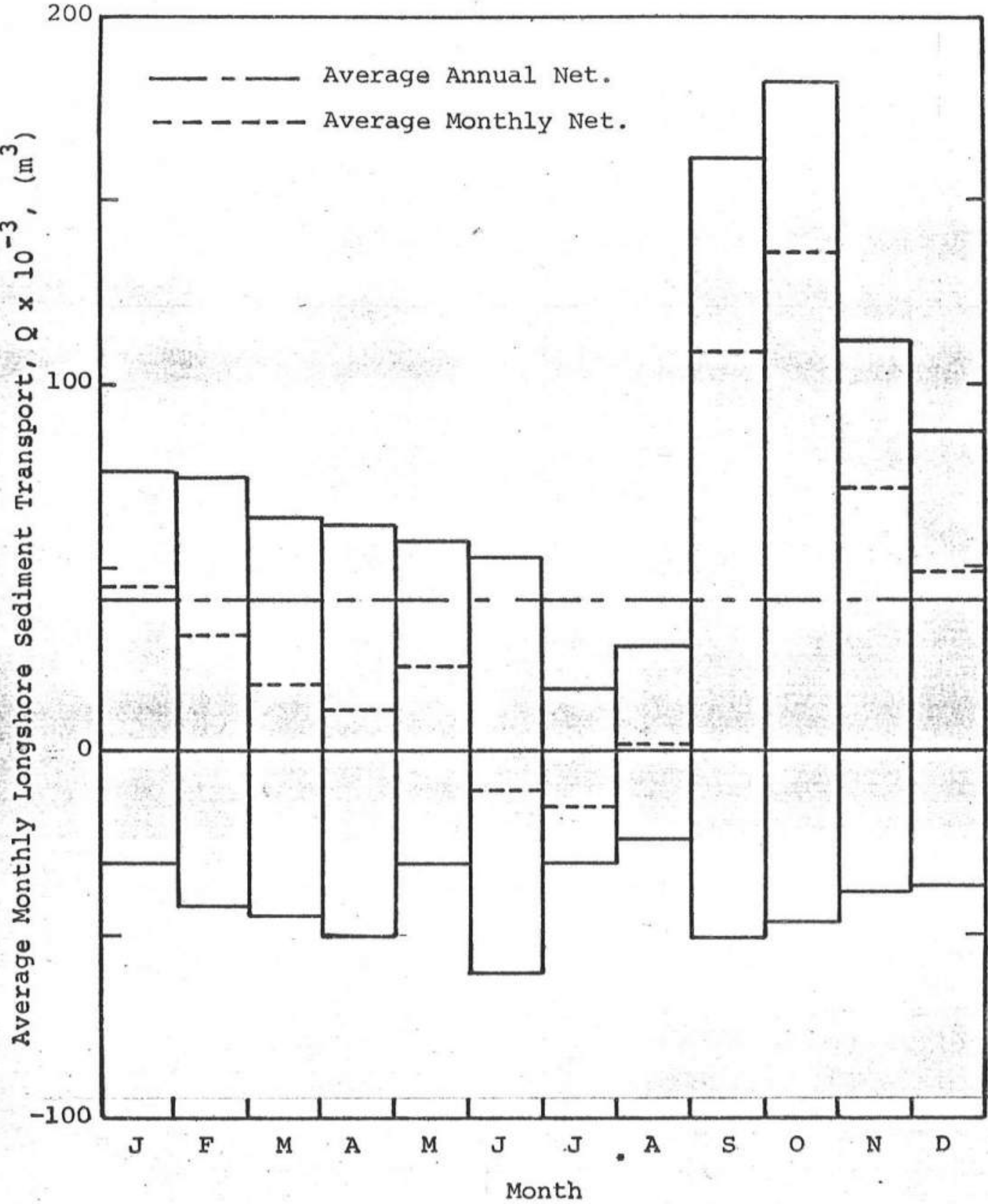


Figure 10. Average Monthly Longshore Sediment Transport Characteristics, 10 Kilometers South of Jacksonville Beach, Florida. Based on Walton (Reference 4).

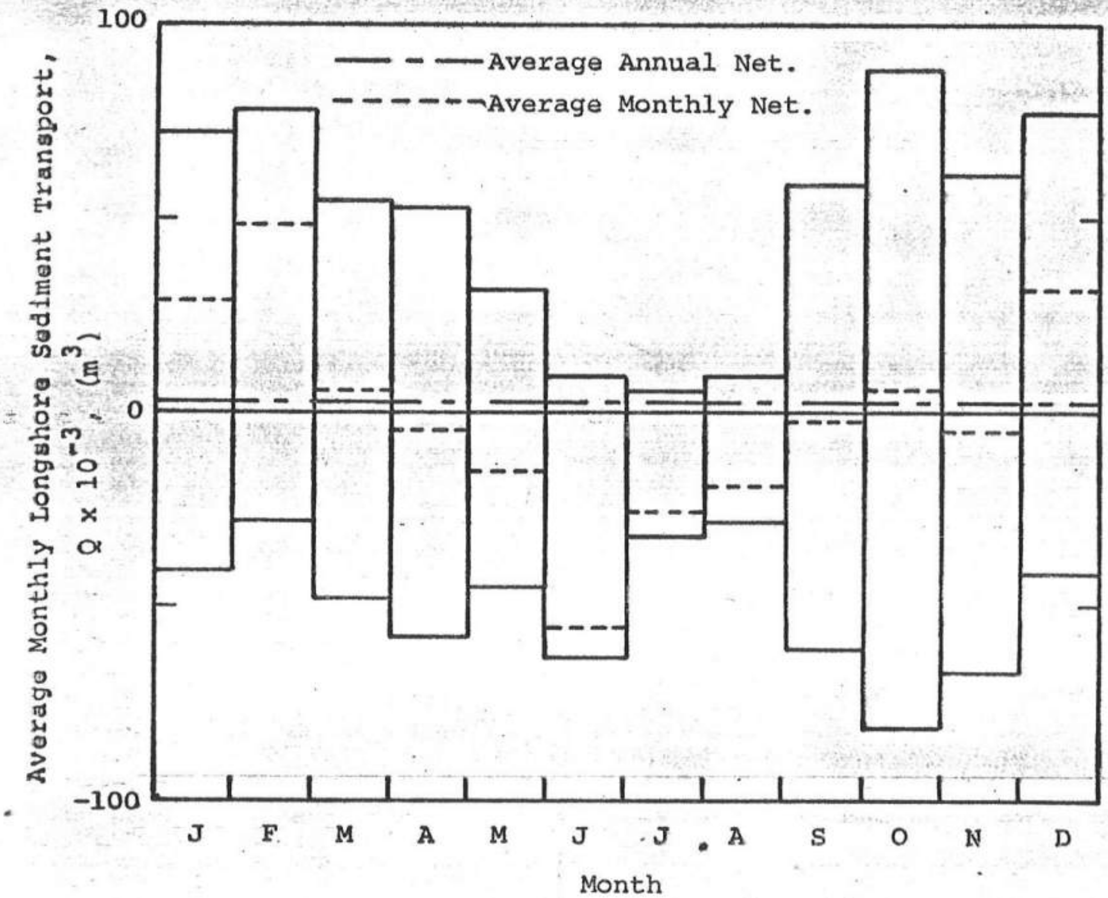


Figure 11. Average Monthly Longshore Sediment Transport Characteristics, Eight Kilometers North of Cape Canaveral, Florida. Based on Walton (Reference 4).

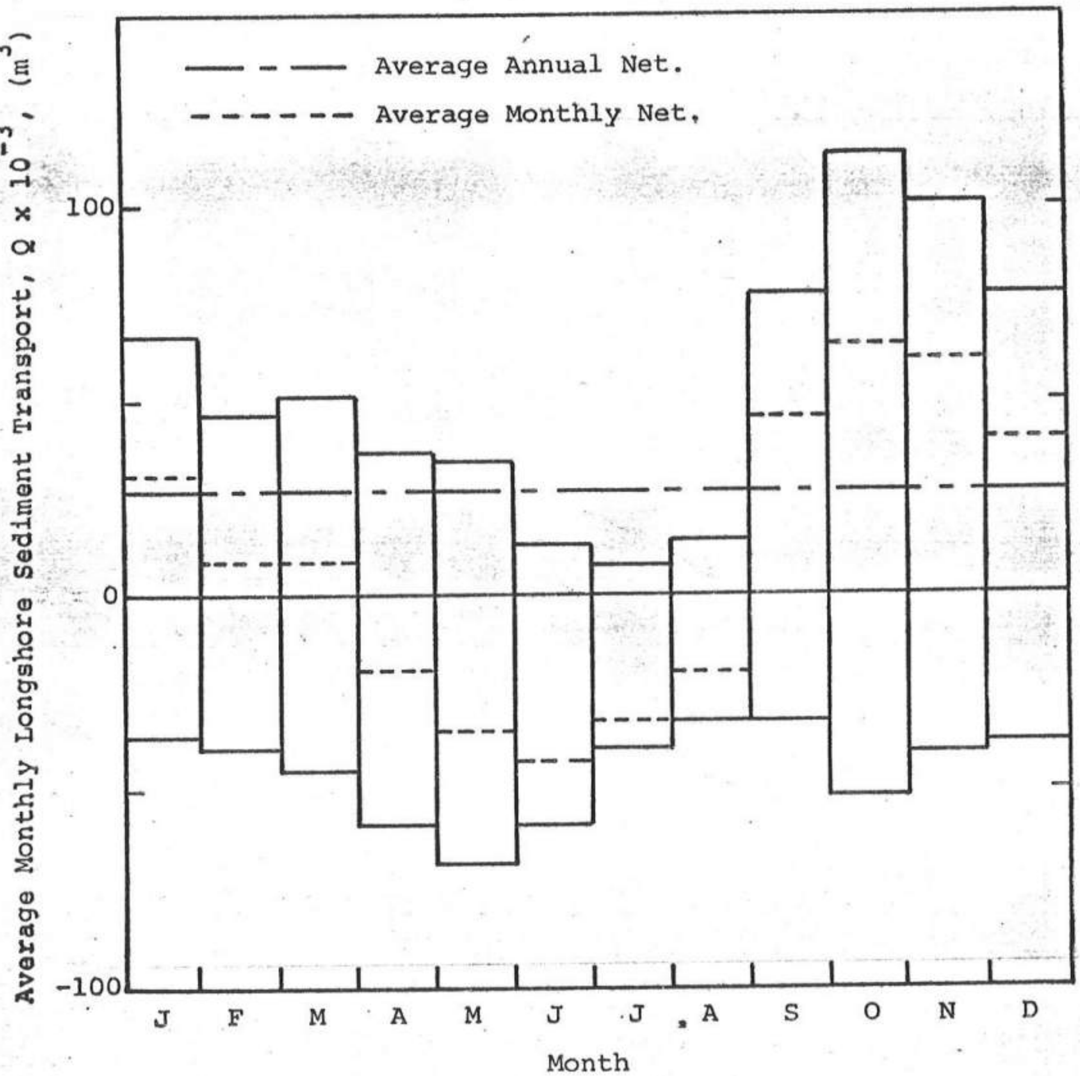


Figure 12. Average Monthly Longshore Sediment Transport Characteristics, Hutchinson Island, Florida. Based on Walton (Reference 4).

Palm Beach Island, FL

The characteristics at this site are similar in all respects to those at the Hutchinson Island site (see Figure 13) and therefore are not considered optimal.

Boca Raton, FL

The longshore sediment transport characteristics at this site are similar to those at the two northerly sites, although the ratio of net to gross transport is slightly higher, see Figure 14 and Table 1.

Miami Beach, FL

The 16 kilometer shoreline segment of Miami Beach includes both Indian Beach Park and Lummus Park. The LEO data at these two sites yield substantially different estimates of longshore sediment transport characteristics. See Figures 15 and 16 and Tables 10 and 11. This area was included to provide continuity; there are no sites known where the logistics are favorable for a trap experiment.

Eglin Air Force Base, FL

This site is located on the Gulf of Mexico shoreline, but was included due to the potential logistical advantages and some appreciation for the relatively favorable longshore sediment transport characteristics. As presented in Figure 17, the mean monthly calculated net longshore sediment transport based on Walton's littoral drift roses is always positive, although nearly balanced during the months of July and August. The transport quantities are large, and Walton, through calibration of the calculated values with impounded quantities at the updrift jetty at Perdido Pass, Alabama (approximately 100 km to the west of Eglin Air Force Base), has determined that the K value of 0.77 predicts transport

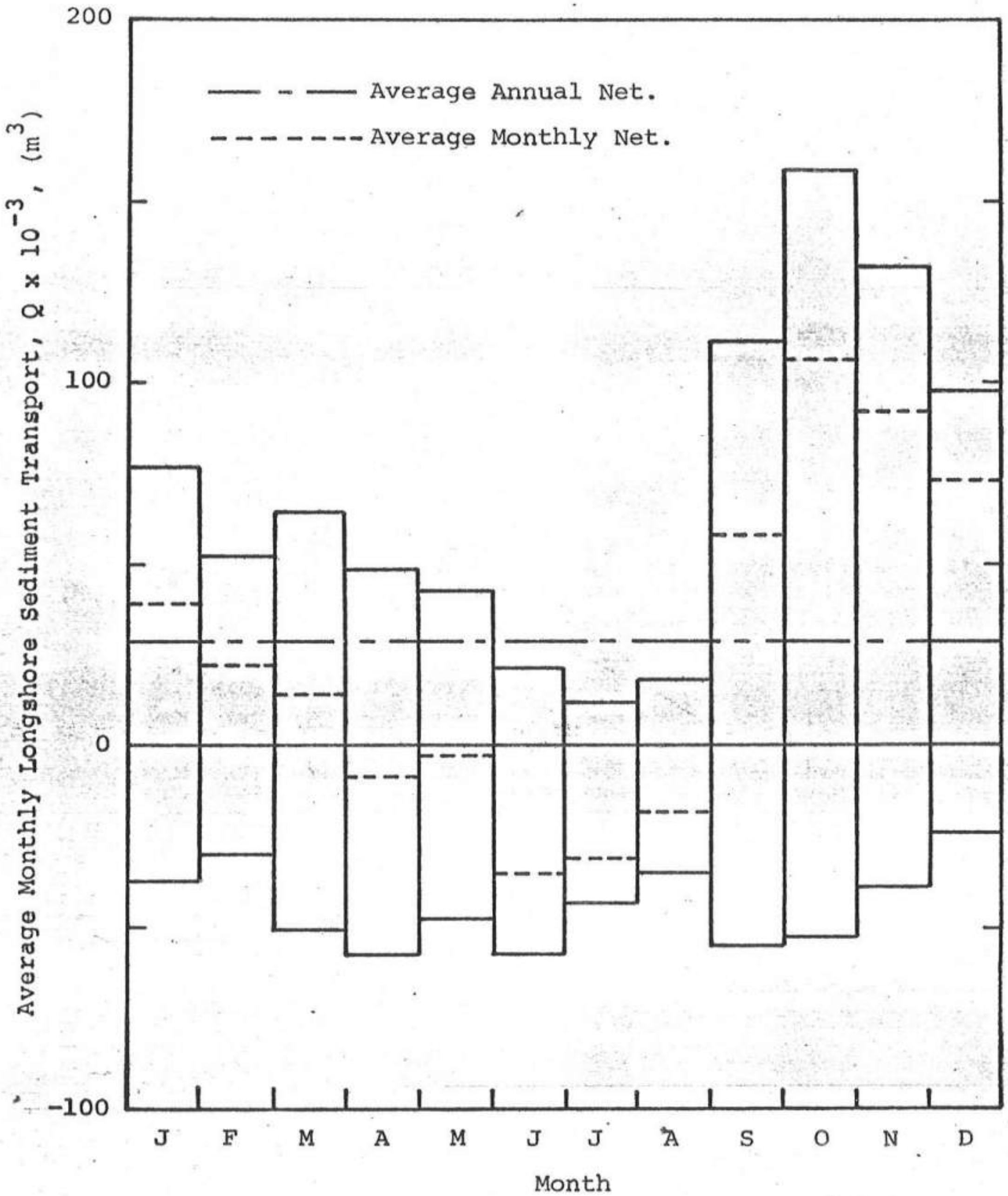


Figure 13. Average Monthly Longshore Sediment Transport Characteristics, Palm Beach Island, Florida. Based on Walton (Reference 4).

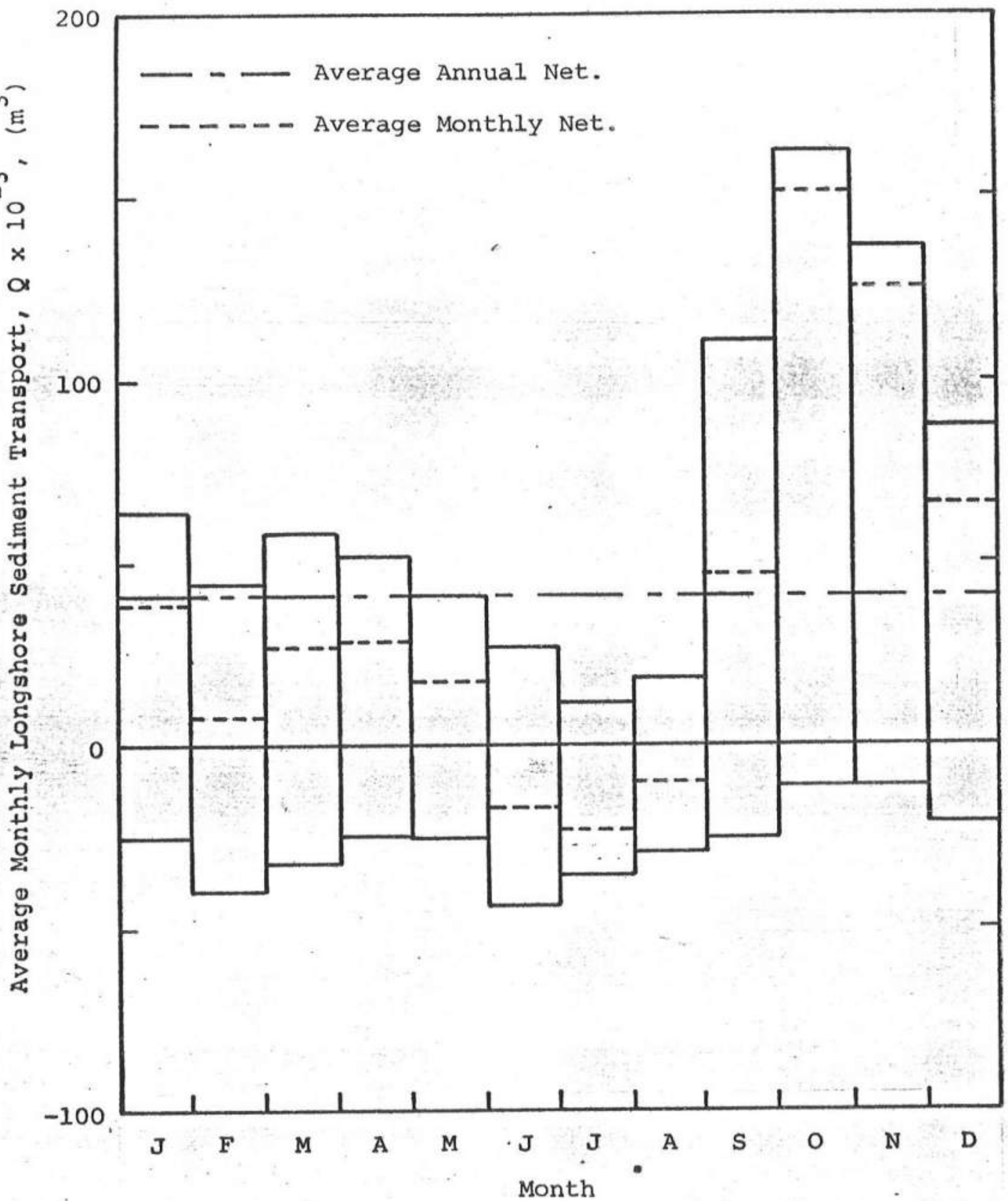


Figure 14. Average Monthly Longshore Sediment Transport Characteristics, Near Boca Raton, Florida. Based on Walton (Reference 4).

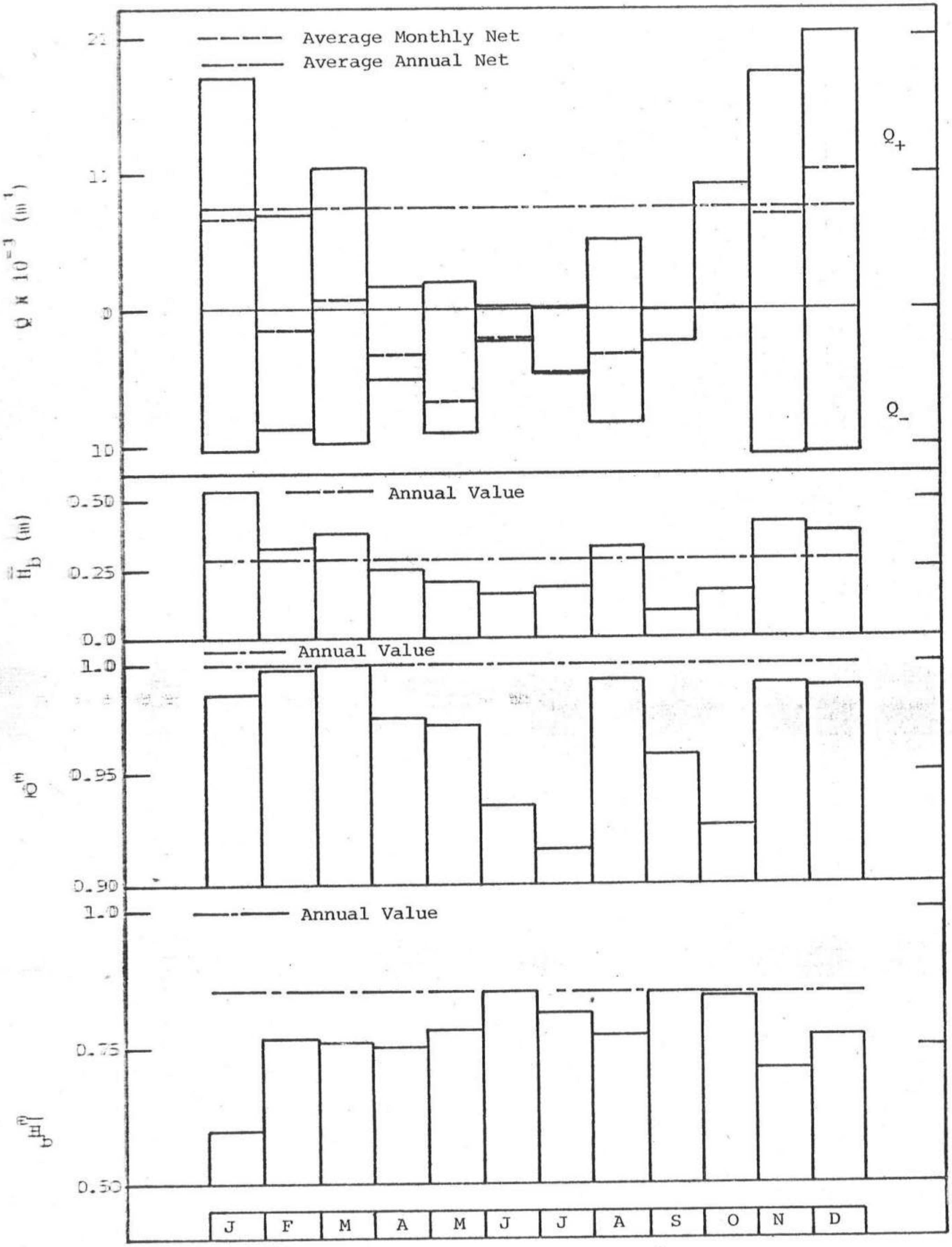


Figure 15. Longshore Transport and Breaking Wave Height Characteristics for Indian Beach Park, FL.

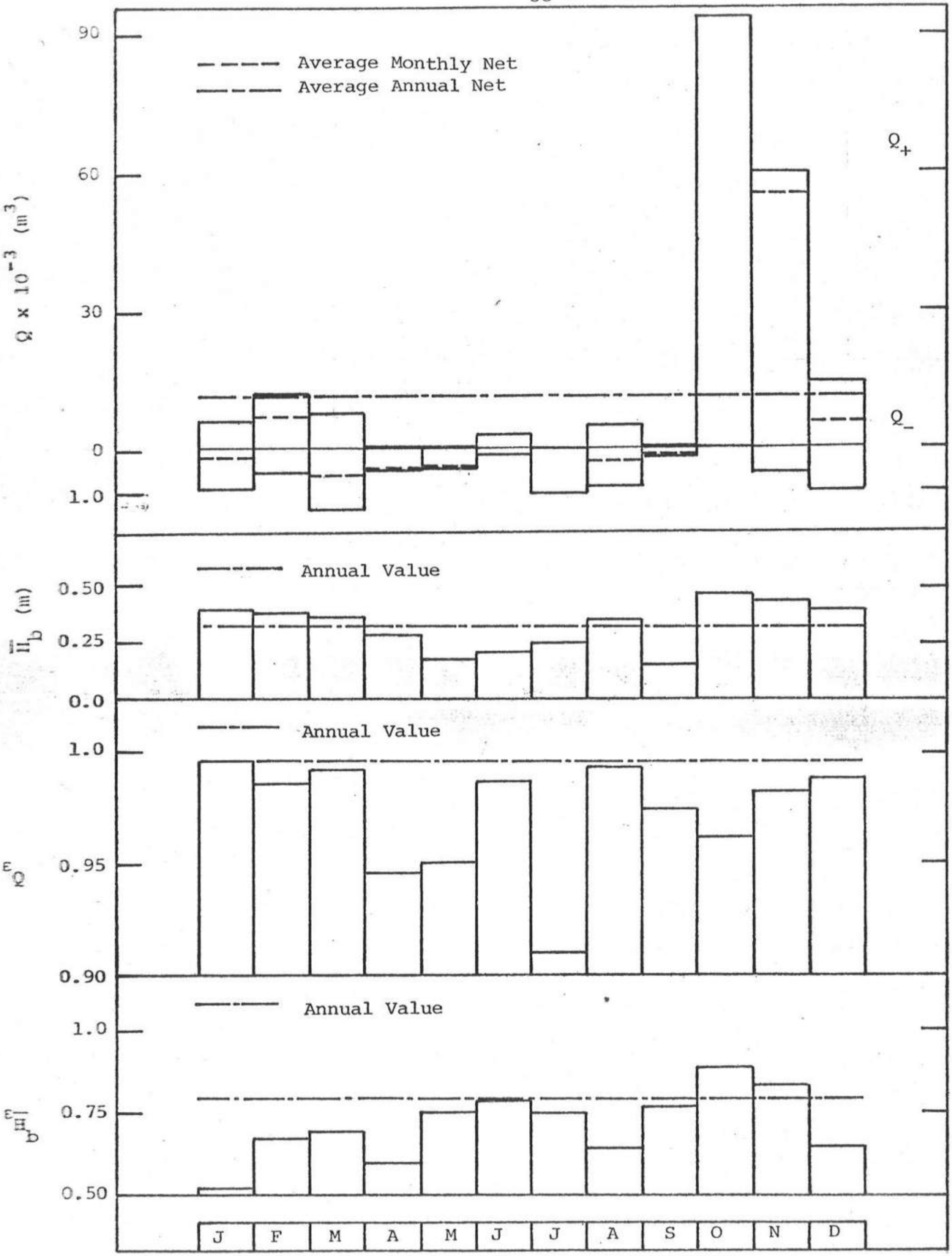


Figure 16. Longshore Transport and Breaking Wave Height Characteristics for Lummus Park, FL.

TABLE 10

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR INDIAN BEACH PARK, FL
(Based on LEO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	16,981	10.246	27,227	6,735	24.7
F	7,062	8,647	15,709	-1,585	10.1
M	10,607	9,783	20,390	824	4.0
A	1,764	4,982	6,746	-3,218	47.7
M	2,053	8,907	10,960	-6,854	62.5
J	155	2,154	2,309	-1,999	86.6
J	118	4,631	4,749	-4,513	95.0
A	5,014	8,265	13,279	-3,251	24.5
S	0	2,308	2,308	-2,308	100.0
O	9,247	0	9,247	9,247	100.0
N	17,503	10,606	28,109	6,897	24.5
D	20,516	10,381	30,897	10,135	32.8
ANNUAL (m^3/yr)	91,020	80,910	171,930	10,110	5.9
ANNUAL AVERAGE (m^3/mo)	7,585	6,743	14,328	842	5.9

Available Leo Data

	Month											
Year	J	F	M	A	M	J	J	A	S	O	N	D
1977							13	31	30	31	30	26
1978	27	27	30	29	30	29	25	26				

Total of 370 Data Points Over Two Years.

TABLE 11

CALCULATED LONGSHORE SEDIMENT TRANSPORT CHARACTERISTICS
FOR LUMMUS PARK, FL
(Based on LEO Data)

	Q_+	Q_-	Q_G	Q_N	Q_N/Q_G (%)
J	6,709	8,027	14,736	-1,318	8.9
F	12,389	4,735	17,124	7,654	44.7
M	7,573	13,000	20,573	-5,427	26.7
A	544	4,354	4,898	-3,810	77.8
M	398	3,710	4,108	-3,312	80.6
J	2,733	797	3,530	1,936	54.8
J	24	9,760	9,784	-9,736	99.5
A	5,136	7,754	12,890	-2,618	20.3
S	311	1,218	1,529	- 907	59.3
O	94,329	0	94,329	94,329	100.0
N	60,334	4,894	65,228	55,440	85.0
D	14,783	8,774	23,557	6,009	25.5
ANNUAL (m^3/yr)	205,263	67,023	272,286	138,240	50.8
AVERAGE ANNUAL (m^3/mo)	17,105	5,586	22,691	11,519	50.8

<u>Available LEO Data</u>

Year	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
1977							13	31	31	31	30	32
1978	26	28	31	30	30	28	27	18				

Total of 380 Data Points Over Two Years.

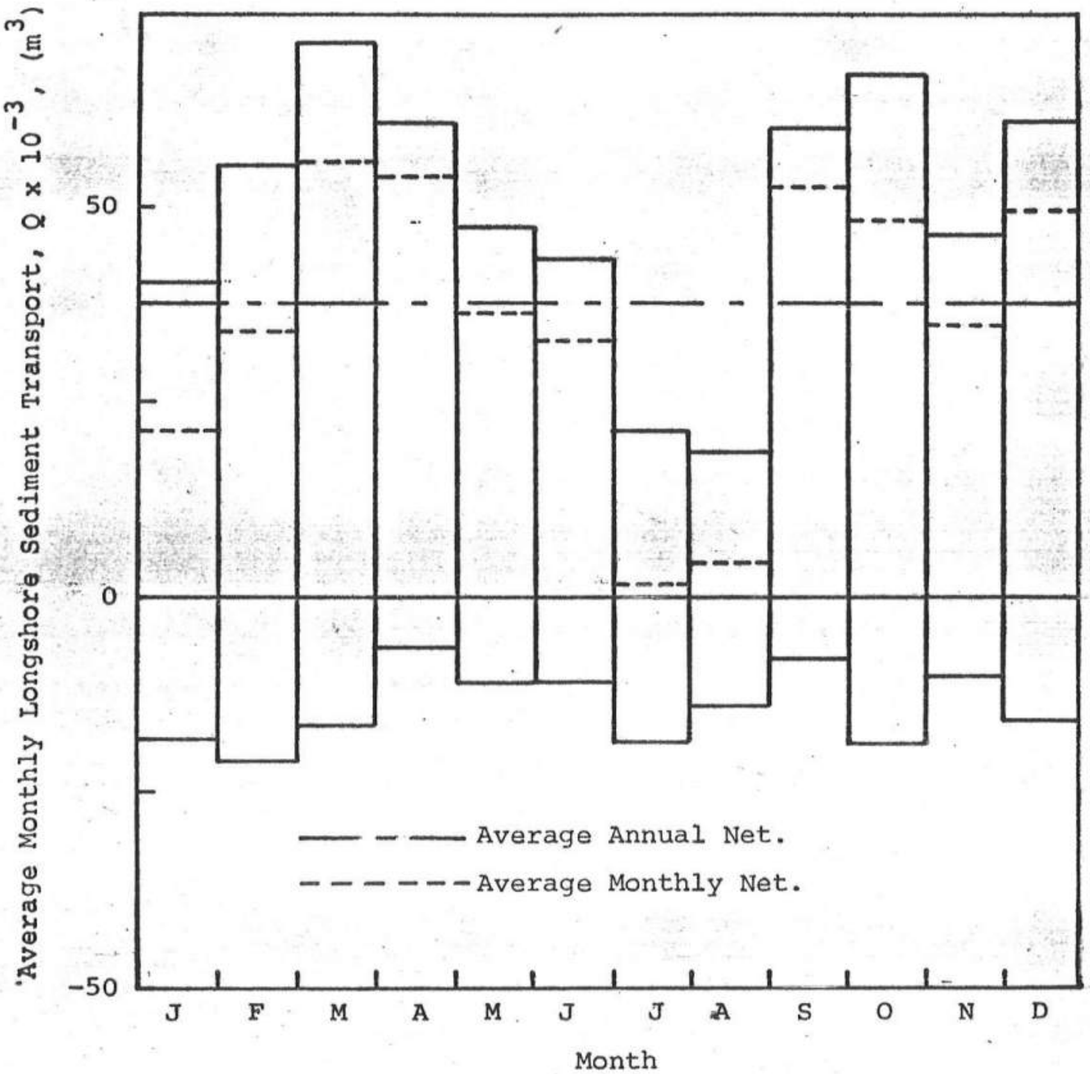


Figure 17. Average Monthly Longshore Sediment Transport Characteristics, Eglin Air Force Base, Florida. Based on Walton (Reference 4).

that is too large by a factor of 2.65. On this basis, the annual net and gross longshore transport values would be 168,000 and 311,000 m^3/yr. For comparison purposes, this net transport is approximately 75% of the corresponding estimated value at Santa Barbara Harbor where the first large scale project is being carried out. As noted, the potential logistical advantages at Eglin Air Force Base are substantial. Access to the beach is reasonably limited, dormitory and other facilities at the base probably could be utilized, and air service to Eglin Air Force Base through Atlanta, GA is reasonable.

SUMMARY AND RECOMMENDATIONS

Summary

The relevant wave, sediment and logistical characteristics have been examined for a number of east coast sites and one Gulf coast site. Unfortunately no existing suitable sediment trap was located. Therefore it will be necessary to include, as a part of the investigative program, the design and installation of a trap. This is not viewed as an entirely negative outcome since the trap can include features designed to be most beneficial to the study. The wave magnitudes and sediment sizes are within reasonably representative ranges for the sites examined. The longshore sediment transport characteristics and shoreline morphology are considered suitable at five of the twelve sites.

There is the potential of substantial logistical advantages if the east coast experiment is carried out at the site of the CERC FRF at Duck, NC. The objectives of this study appear to be strongly aligned with those of CERC and there are opportunities to enhance substantially the knowledge pertaining to longshore sediment transport mechanics through joint efforts. Attempts to determine the level of logistical and other support have not yielded definitive results to date.

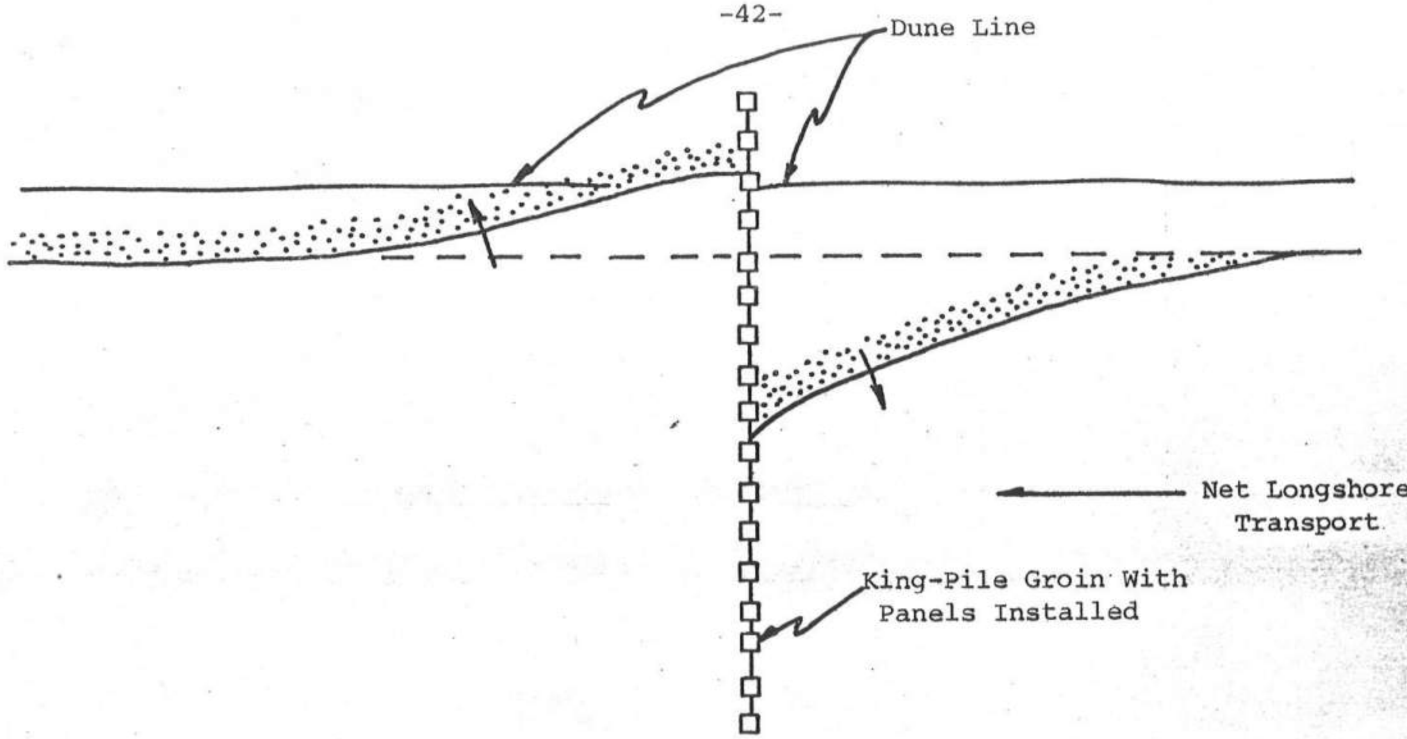
Two site recommendations are presented below. The first is based on the premise that the study will be enhanced logistically by being located at the FRF. The second recommendation outlines a possible alternative if difficulties materialize in carrying out the experiment at the FRF.

Recommended Site

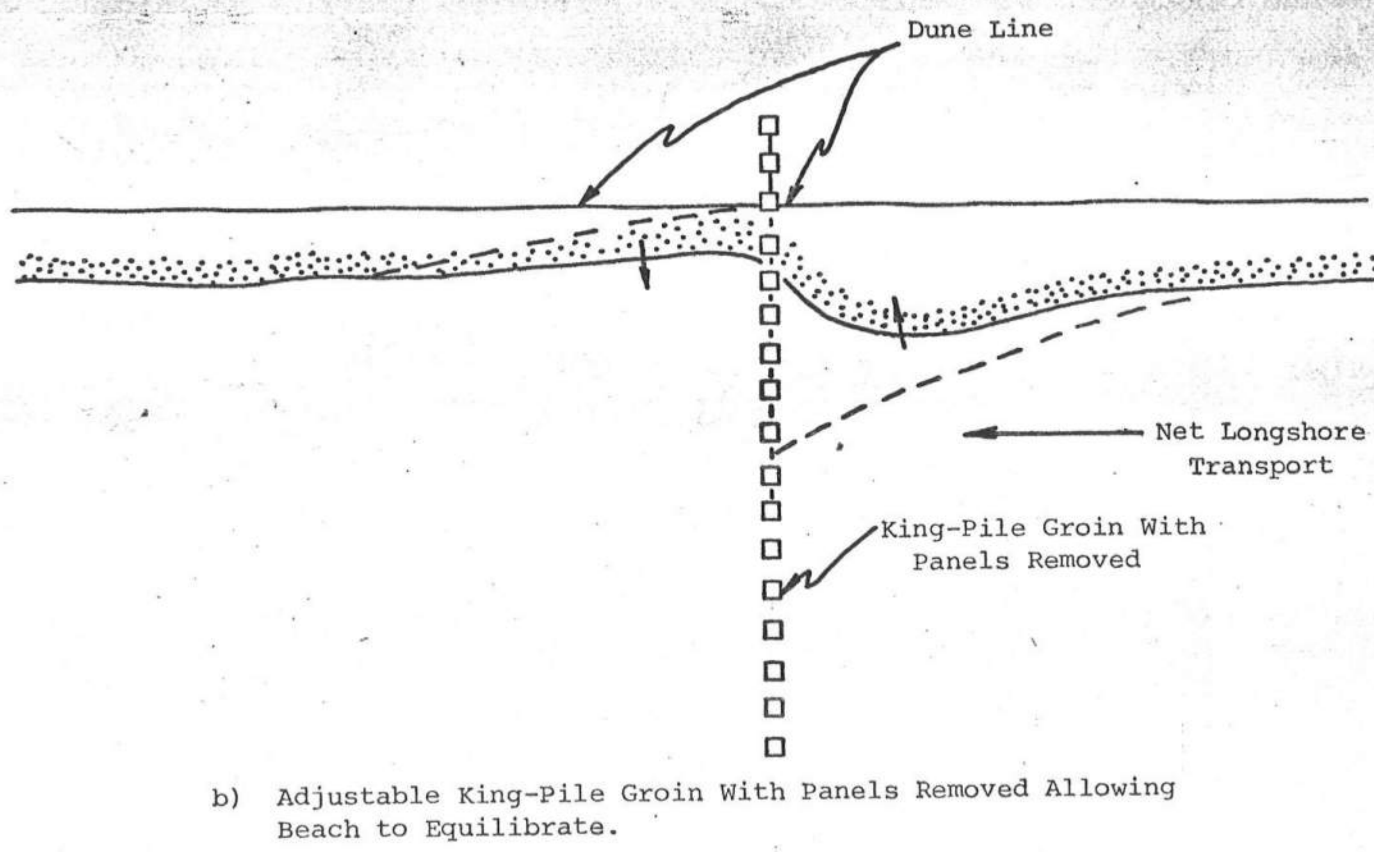
This recommendation presumes that there will be substantial logistical advantages and possibly program support if the east coast trap experiment is carried out at the FRF at Duck, North Carolina. Potential logistical advantages include: an 1800 m segment of beach dedicated to coastal engineering research, involvement of and interaction with CERC personnel, permission to place a "trap" across the littoral zone (although NSTS may have to obtain the necessary environmental approvals), availability of wave, tide and currents routinely measured at the FRF and partial support of the program.

The disadvantages of the FRF site relating to uncertainties in apparently highly variable longshore sediment transport characteristics, a poorly sorted sediment and generally poor underwater visibility have been presented; however, they are not considered to be so extreme as to not recommend the site for consideration.

In order to carry out impoundment measurements without the cost of a fairly massive structure, it is recommended that a trap facility such as shown in Figures 18, 19 and 20 be constructed. Basically, the trap would be an adjustable groin design, and would offer the possibility of impounding material for short durations, say up to two weeks, measuring the volume impounded, removing the panels, allowing the beach to equilibrate and then repeating the experiment (Figure 18). For more extended periods of operation, with the panels installed, the structure could function as a littoral barrier with the impounded



a) Adjustable King-Pile Groin Functioning as a Nearly Complete Littoral Barrier.



b) Adjustable King-Pile Groin With Panels Removed Allowing Beach to Equilibrate.

Figure 18. Use of King-Pile Groin to Impound Sand, Followed by Period of Beach Equilibration.

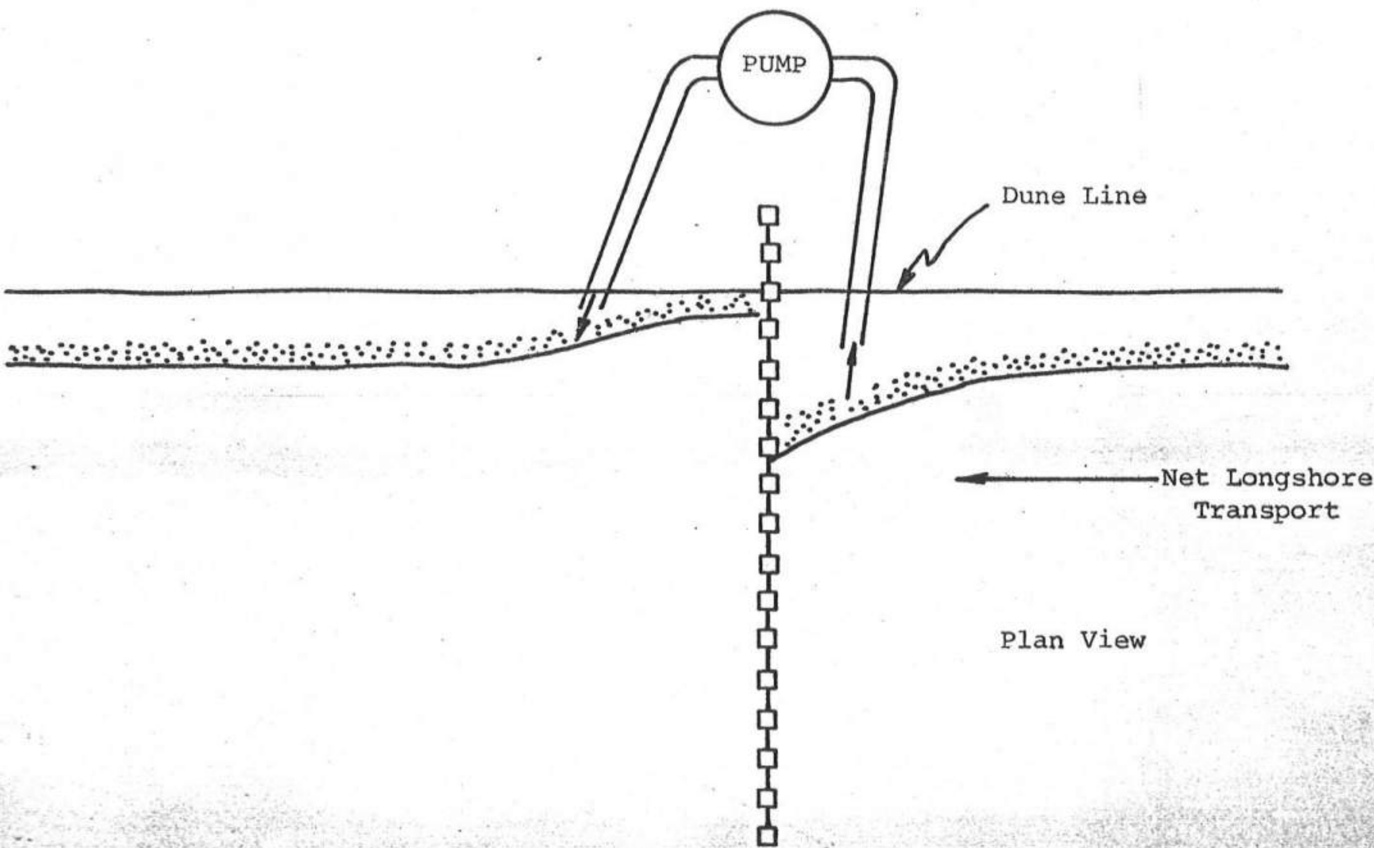


Figure 19. Use of King-Pile Groin and Intermittent Bypassing to Limit Shoreline Perturbation.

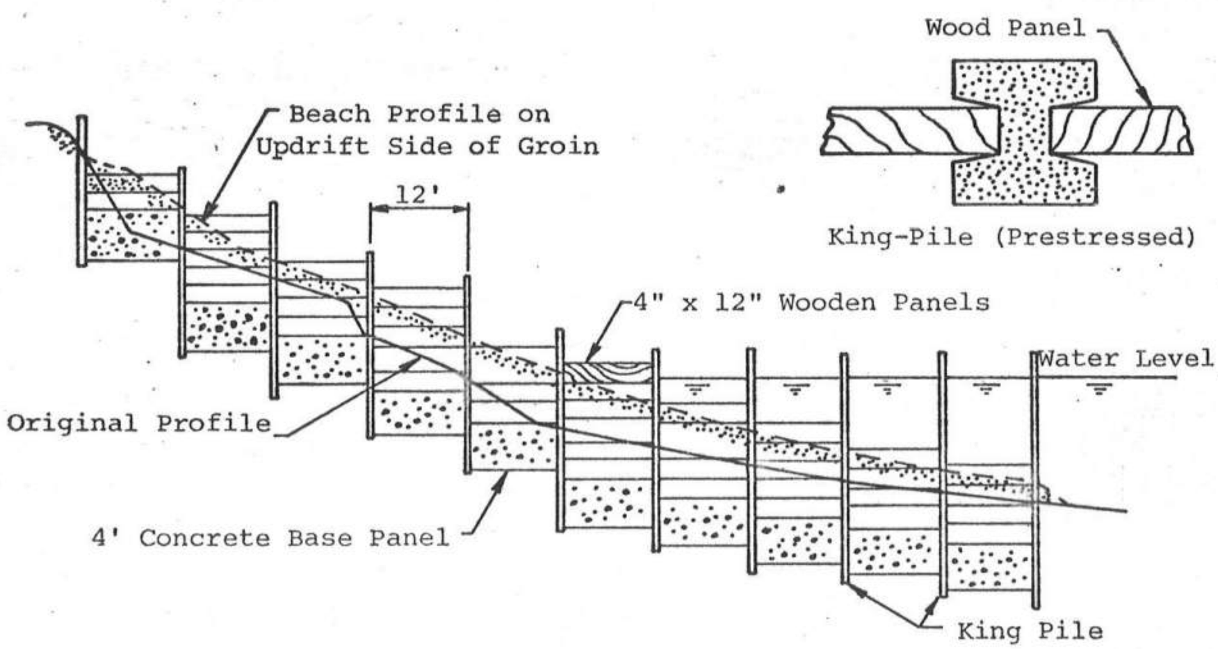


Figure 20. King-Pile Groin Design.

material measured and transferred downdrift by a small dredge pump (Figure 19). The determination of volumes of material trapped could be carried out through first pumping and temporary storage and measurement in a sand-diked area, followed by distributing the material on the beach with earth-moving equipment. In this latter mode, the impoundment period could be extended almost indefinitely without much natural bypassing around the structure by reducing the amount of updrift perturbation of the shoreline through removal of material at selected locations. The estimated required length of the groin is 60 m and the construction costs should be less than $1000/m. Figure 20 shows some of the construction details associated with an adjustable King-Pile groin.

Recommended Alternate Site

If the potential of developing a "trap" at the FRF site does not materialize, it is recommended that consideration be given to the Eglin Air Force Base site. The potential merits of this site have been reviewed in a previous section and include: favorable longshore sediment transport characteristics, a beach with limited access, use of dormitory and other facilities, reasonably efficient air travel to the site and generally good underwater visibility during most of the year. The University of Florida has a branch campus at the Base and the proximity of the Naval Coastal System Laboratory at Panama City could be advantageous. The same type of King-Pile structure as was discussed in conjunction with the Duck site should be effective at the Eglin Air Force Base site. This site is more prone to the occurrence of hurricanes than is the Duck site and large-scale rhythmic shoreline topography has been observed near the site.

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