EVALUATION OF BEACH COMPACTNESS FOLLOWING MAINTENANCE RENOURISHMENT

Project #105-525

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Mote Marine Laboratory Technical Report No. 520
April 11, 1997

Suggested reference Foote JJ, Truitt C. Evaluation of beach compactness following maintenance renourishment. Town of Longboat Key Project #105-525. Mote Marine Laboratory Technical Report no 520. 3 p and tables.
(Available from Mote Marine Laboratory Library)

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BACKGROUND

The Town of Longboat Key completed an island-wide beach restoration project in the summer of 1993. In the first year to year and a half following that completion, certain sections of the project experienced much higher than expected cross-shore adjustments resulting in three distinct erosional “hot spots” near mid-key. Hurricane Opal passed offshore through the Gulf in the fall of 1995 producing sufficient wave energy on the Key to cause a further general loss of sand and the aggregation of the three spots into one, three mile-long segment which returned to the pre-1993 eroded condition. The Town’s engineering consultant recommended and designed an interim renourishment project to restore the mid-key area to its intended width and put the project back its original schedule for long-term maintenance.

Permits were issued for this interim renourishment by the Florida Department of Environmental Protection (FDEP) (permit no. 582830959) and the US Army Corps of Engineers (USACE) (modification to permit no. 199100296). The borrow source for the interim project was a sand dome located some 5 to 7 miles off the key rather than the adjacent pass ebb shoals as had been used in 1993. Approximately 827,000 cubic yards of coarse fill was to be placed by hopper dredge along the key from DNR monument R-14 in Sarasota County, north across the county line, to monument R-65 in Manatee County. After the permits were approved and the construction contract signed, Tropical Storm Josephine further damaged the beach, especially the section north of the originally proposed fill area. Permits were modified and a construction change order issued to stockpile an additional 55,000 cubic yards of sand at the original north project limit and place that sand by mechanical means (earthmoving equipment) along the next 3,500 feet north. The interim project was scheduled during the 1996-97 winter season and the sand fill was completed in February 1997.

The compactness of the sand after placement has been raised as a concern about restoring eroding beaches with dredged borrow material. Hydraulically-placed fill indeed can exhibit a more compact structure than the native beach sand and a limited number of previous studies have been performed which attempt to relate the compactness of the beach to nesting activity (e.g., Nelson and Dickerson, 1989).

These previous studies, at Delray and other Florida east coast fill projects, led to threshold penetrometer values which subsequently have been adopted by regulatory agencies and used to determine a need for post-project scarifying of the beach to reduce compactness. For example, requiring that the compactness of the filled beach be measured prior to the nesting season following project completion and the criterion of “tilling” all areas exceeding a value of 500 Cone Penetrometer (Index) Units are included as requirements in both of the Town’s regulatory permits.

SCOPE AND MEASUREMENT PROCEDURES

On April 2, 1997 Mote Marine Laboratory (MML) investigators measured compactness along the entire length of the Interim Coarse Fill Project, from approximately R-14 to R-62. The methodology and equipment used was the same as described by Nelson et. al. (1987). A hand-held cone penetrometer is pushed into the sand and the resistance is indicated by a dial which measures the deflection of an integral proving ring. At each of the test stations compactness was measured in a vertical series at three depths: 0-6 inches, 6-12 inches, and 12-18 inches. Measurements are recorded in Cone Index Units (termed CIU or CPU) up to the dial maximum; values at the maximum are recorded as "999" to indicate that it is not known by how much the actual compactness would have exceeded the dial capacity.

Measuring procedures recommended by US Fish and Wildlife Service for restored beaches call for testing stations randomly along the beach length in a "zig-zag" pattern. A slightly different approach was used to ensure more uniform coverage and greater numbers of data. Representative testing lines were selected at each FDNR Coastal Construction Control Line survey profile (approximately every 1000 ft) and at the intervening points mid-way between each monument, resulting in measurements at least every 500 feet along the beach,.

On each line measurements were made at spots across the entire dry, sandy beach from below the dune line to the water line in the area typical of nesting activity. If the beach at the regular monument point was sufficiently wide (75 to 100 ft), three stations were measured across the profile: within 10-15 ft of the vegetation line, at mid-berm, and within 5-10 ft of the approximate average water line. At the intervening test lines (500 feet) a single station was selected representative of the mid-berm area. The resulting pattern of 3 tests, then one, then 3, etc, combined with the variable beach width reasonably meets the intent of the recommended "zig-zag" pattern.

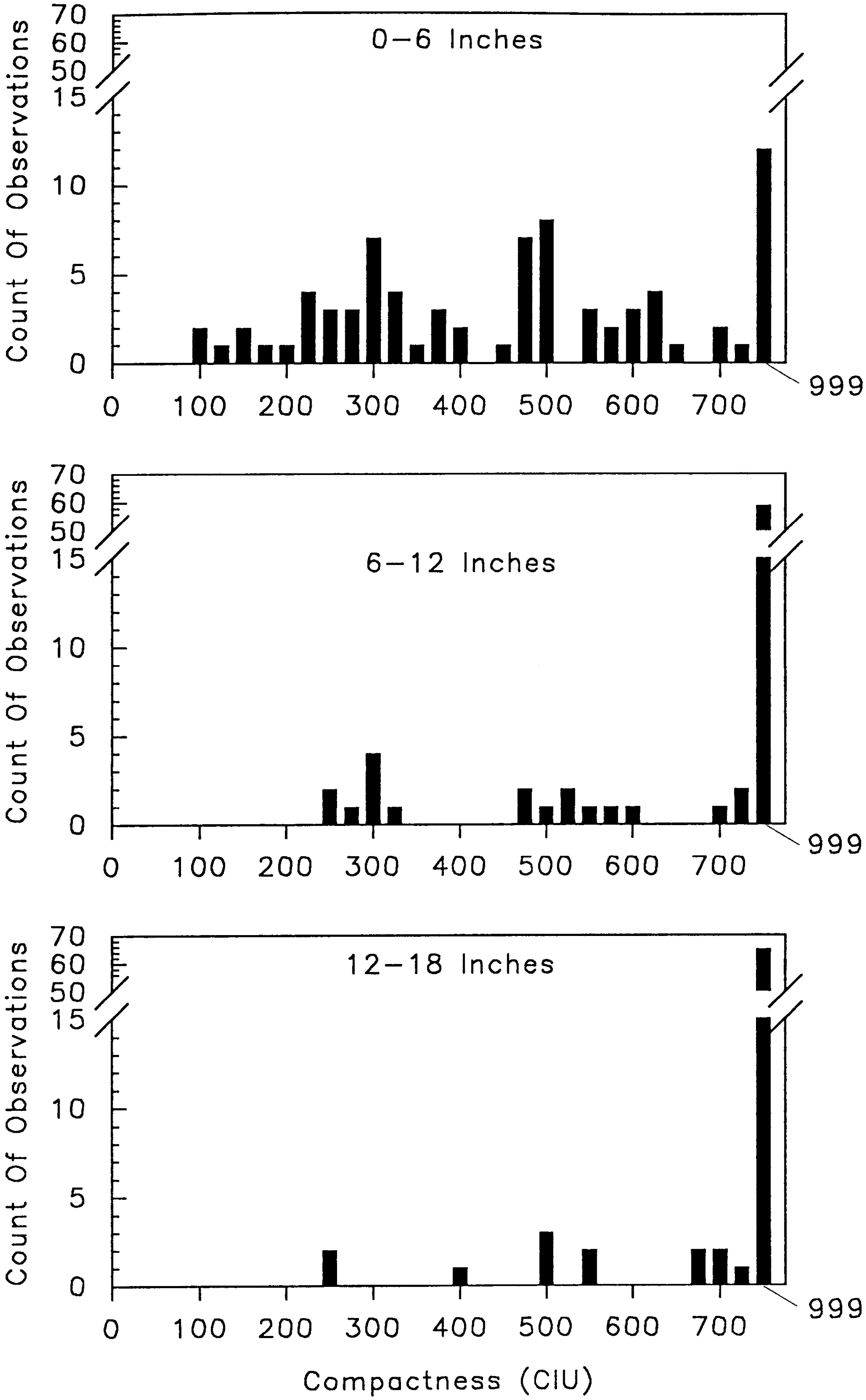
The field measurements of compactness were evaluated and analyzed for any trends. These analyses form the basis for a general characterization of post-project beach compactness.

RESULTS AND DISCUSSION

The above procedures resulted in a total of 234 individual measurements at 78 test stations. Study results are presented in this report in three formats. Table 1 is a summary of the processed data showing the averages, ranges and other statistical parameters for all compactness measurements at each cross-shore location. These values are further divided by the depth into the beach (i.e., 6, 12 and 18 inch readings). Figure 1 summarizes the frequency of occurrence of compactness values at each of the three depths. Table 2 presents all the actual compactness measurements organized by monument line, and showing the cross-shore location in comparison to the overall beach width. The following paragraphs briefly discuss the results, progressing from the most general averages to more detailed trends.

Table 1. Summary of compactness readings for lower, mid and upper beach areas.

	Compactness (CIU) 0-6 inches	Compactness (CIU) 6-12 inches	Compactness (CIU) 12-18 inches
Lower Beach			
Count	20	20	20
Mean	288	690	799
S.D.	121	307	249
Minimum	100	250	250
Maximum	500	999	999
Mid Beach			
Count	38	38	38
Mean	637	987	990
S.D.	262	77	53
Minimum	250	525	675
Maximum	999	999	999
Upper Beach			
Count	20	20	20
Mean	442	817	914
S.D.	206	280	214
Minimum	125	250	250
Maximum	999	999	999



0-6 Inches
6-12 Inches
12-18 Inches
Count Of Observations
70
60
50
15
10
5
0
0
100
200
300
400
500
600
700
999
Compactness (CIU)

The overall average compactness for all stations, depths and areas was 762 CIU which is a statistically significant higher value than the regulatory criterion. A previous similar study of these same beaches prior to restoration (Foote and Truitt, 1993) concluded that the overall average for native sand areas was 716 CIU. Relatively small differences within a data set where the stations are randomly selected and natural variability is great should not be considered significant. However, a reasonable first conclusion from the above averages is that the recently placed fill sand is statistically more compact overall than was the native sand beach on Longboat Key, but both conditions exceed the typical regulatory criteria for restored beaches.

Overall averages for all areas at each different test depth (6, 12 and 18 inches) are 497 CIU, 867 CIU, and 921 CIU, respectively, indicating a clear increase in compactness with depth. Averages for each depth, but grouped by position across the beach (Table 1) show higher averages at mid-beach than near either the waterline or dune line. The overall average value to a depth of 6 inches (497) is slightly lower than the regulatory criteria of 500 CIU. In fact, of the 78 stations tested, 44 (56%) had readings below 500 CIU down to a depth of 6 inches. Examination of Table 2 suggests that these lower values occurred more frequently in the southern half of the project while the higher surface compactness was found in the mechanically placed fill at the north. In contrast, only 10 stations had values less than 500 at 12 inches and only 3 readings fell below 500 at 18 inches, further supporting the conclusion that for this study area, compactness of the surface layer is a poor indicator of sand conditions immediately below at the depths where nests are typically excavated.

REFERENCES

Foote, J. J. and Truitt, C. 1993. “Sea Turtle Protection Measures Including Nest and Sand Compactness Monitoring for Longboat Key, ” Mote Marine Laboratory Technical Report No. 313, Sarasota, Fla.

Nelson, D.A., Mauck, K. and Fletemeyer, J. 1987. “Physical Effects of Beach Nourishment on Sea Turtle Nesting, Delray Beach, Florida,” Technical Report EL-87-15, US Army Waterways Experiment Station, Vicksburg, Miss.

Nelson, D.A. and Dickerson, D.D. 1989. “Effects of Beach Nourishment on Sea Turtles,” Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology,” NOAA Technical Memorandum NMFS-SECF-232, National Marine Fisheries Service, Southeast Fisheries Center, Miami, Florida.

Table 2. Complete database of compactness readings

County	Nearest FLDNR Marker	Feet South	Location on Beach (L,M,U)	Distance to High Water (feet)	Distance to Vegetation (feet)	Beach Width (feet)	Compactness (CIU) 0-6 inches	Compactness (CIU) 6-12 inches	Compactness (CIU) 12-18 inches
Manatee	62	0	L	15	85	100	475	999	999
Manatee	62	0	M	50	50	100	999	999	999
Manatee	62	0	U	85	15	100	500	999	999
Manatee	62	500	M	50	50	100	999	999	999
Manatee	63	0	L	5	130	135	500	999	999
Manatee	63	0	M	70	65	135	999	999	999
Manatee	63	0	U	125	10	135	325	575	999
Manatee	63	500	M	45	45	90	625	999	999
Manatee	64	0	L	10	90	100	500	999	999
Manatee	64	0	M	55	45	100	999	999	999
Manatee	64	0	U	85	15	100	999	999	999
Manatee	64	500	M	75	75	150	999	999	999
Manatee	65	0	L	10	150	160	300	475	999
Manatee	65	0	M	85	75	160	999	999	999
Manatee	65	0	U	145	15	160	400	999	999
Manatee	65	500	M	90	90	180	700	999	999
Manatee	66	0	L	5	160	165	300	999	999
Manatee	66	0	M	85	80	165	999	999	999
Manatee	66	0	U	145	20	165	225	500	999
Manatee	66	500	M	100	100	200	550	999	999
Manatee	67	0	L	5	140	145	300	999	999
Manatee	67	0	M	75	70	145	550	999	999
Manatee	67	0	U	135	10	145	500	999	999
Sarasota	1	0	L	10	160	170	275	300	550
Sarasota	1	0	M	75	95	170	450	999	999
Sarasota	1	0	U	150	20	170	500	999	999
Sarasota	1	500	M	75	75	150	600	999	999
Sarasota	2	0	L	15	160	175	150	300	500
Sarasota	2	0	M	85	90	175	375	999	999

Table 2 (continued). Complete database of compactness readings

County	Nearest FLDNR Marker	Feet South	Location on Beach (L,M,U)	Distance to High Water (feet)	Distance to Vegetation (feet)	Beach Width (feet)	Compactness (CIU) 0-6 inches	Compactness (CIU) 6-12 inches	Compactness (CIU) 12-18 inches
Sarasota	2	**0**	U	170	5	175	600	**999**	**999**
Sarasota	2	500	M	120	120	240	600	**999**	**999**
Sarasota	3	0	L	15	200	215	100	**999**	**999**
Sarasota	3	0	M	115	100	215	575	**999**	**999**
Sarasota	3	0	U	205	10	215	175	250	550
Sarasota	3	500	M	125	125	250	999	999	999
Sarasota	4	0	L	20	205	225	475	999	999
Sarasota	4	0	M	100	125	225	999	999	999
Sarasota	4	0	U	200	25	225	300	999	999
Sarasota	4	500	M	150	150	300	650	999	999
Sarasota	5	0	L	5	300	305	275	600	999
Sarasota	5	0	M	155	150	305	500	999	999
Sarasota	5	0	U	295	10	305	500	999	999
Sarasota	5	500	M	120	120	240	475	999	999
Sarasota	6	0	L	15	200	215	200	475	500
Sarasota	6	0	M	115	100	215	400	999	999
Sarasota	6	0	U	195	20	215	375	999	999
Sarasota	6	500	M	80	80	160	500	999	999
Sarasota	7	0	L	10	140	150	100	325	400
Sarasota	7	0	M	75	75	150	300	999	999
Sarasota	7	0	U	140	10	150	550	999	999
Sarasota	7	500	M	90	90	180	725	999	999
Sarasota	8	0	L	10	150	160	250	250	250
Sarasota	8	0	M	85	75	160	999	999	999
Sarasota	8	0	U	150	10	160	475	999	999
Sarasota	8	500	M	90	90	180	475	999	999
Sarasota	9	0	L	20	135	155	225	999	999
Sarasota	9	0	M	75	80	155	325	999	999
Sarasota	9	0	U	150	5	155	150	275	250

Table 2 (continued). Complete database of compactness readings

County	Nearest FLDNR Marker	Feet South	Location on Beach (L,M,U)	Distance to High Water (feet)	Distance to Vegetation (feet)	Beach Width (feet)	Compactness (CIU) 0-6 inches	Compactness (CIU) 6-12 inches	Compactness (CIU) 12-18 inches
Sarasota	**9**	500	M	100	100	200	300	**999**	**999**
Sarasota	10	0	L	10	170	180	250	700	675
Sarasota	10	0	M	100	80	180	300	999	999
Sarasota	10	0	U	170	10	180	325	725	999
Sarasota	10	500	M	90	80	170	250	999	999
Sarasota	11	0	L	10	165	175	225	300	700
Sarasota	11	0	M	75	100	175	325	999	999
Sarasota	11	0	U	165	10	175	575	725	999
Sarasota	11	500	M	100	100	200	475	999	999
Sarasota	12	0	L	10	230	240	225	525	725
Sarasota	12	0	M	120	120	240	625	999	999
Sarasota	12	0	U	212	28	240	125	300	500
Sarasota	12	500	M	125	80	205	475	999	999
Sarasota	13	0	L	5	135	140	350	999	999
Sarasota	13	0	M	65	75	140	700	999	999
Sarasota	13	0	U	120	20	140	625	999	999
Sarasota	13	500	M	80	80	160	999	999	999
Sarasota	13	750	L	5	160	165	288	550	700
Sarasota	13	750	M	75	90	165	375	525	675
Sarasota	13	750	U	150	15	165	625	999	999