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EXPERIMENTAL DUNES OF THE TEXAS COAST

by

Bard O. Gage

MISCELLANEOUS PAPER NO. 1 - 70

JANUARY 1970

U. S. ARMY, CORPS OF ENGINEERS
COASTAL ENGINEERING
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ABSTRACT

Storms and increased habitation on barrier islands have reduced the height and width of dunes on the Texas Coast, thereby exposing it to the surges and waves produced by tropical storms in the Gulf of Mexico.

This publication reports on experimental means of creating and stabilizing sand dunes to protect the coast. Four locations were selected; the SW end of Galveston Island, Packery Channel, Newport Pass on North Padre Island and Corpus Christi Pass.

Low areas of the barrier islands were planted in various types of vegetative cover in an attempt to establish dunes without the aid of sand fences. Snow fencing was used to accumulate windblown sand and vegetative planting made to stabilize dunes. Junk car bodies were placed in line parallel to beaches and used instead of more conventional means to establish and stabilize dunes by trapping sand.

Since snow fences are more effective and much cheaper, junk cars are not recommended for building dunes.

FOREWORD

CERC has a program to collect data to enable coastal engineers to stabilize existing dunes and to build artificial ones as protective structures. This paper is published to give wider dissemination to significant information on dune "growing".

The sand dune experiments and data collections were conducted by the author, Bard O. Gage, a planning engineering in the Coastal Studies Section of the Galveston District, Corps of Engineers.

At the time of publication, Lieutenant Colonel Edward M. Willis was Director of the Center; Joseph M. Caldwell was Technical Director.

NOTE: Comments on this publication are invited. Discussion will be published in the next issue of the CERC Bulletin.

This report is published under authority of Public Law 166, 79th Congress, approved July 31, 1945, as supplemented by Public Law 172, 88th Congress, approved November 7, 1963.

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1. INTRODUCTION

During April 1965 the Galveston District, Corps of Engineers, began experiments to determine the practicability of creating and stabilizing sand dunes on low areas of the barrier islands of the Texas coast. The work was in connection with preliminary studies to provide hurricane flood protection to long reaches of the Texas coast.

House Document 693, 66th Congress, 2nd Session, and many historical records indicate that before the 19th century the coastal barrier islands had higher and wider dunes than now exist. In recent years, increased habitation of the barrier islands has destroyed much of the vegetation, resulting in erosion and weakening of the dunes. Larger, more stable dunes parallel to the shoreline would provide greater protection from surges and waves produced by tropical storms in the Gulf of Mexico.

The experiments involved placing sections of flexible snow fencing to accumulate windblown sand behind the fences, and vegetative planting to stabilize the dunes. A few small low areas of the barrier islands were planted in grass by seeding and sprigging in an effort to establish vegetative cover and create dunes without the aid of sand fences. Abnormally high tides during October 1965 and May and October 1966 washed channels through some fence-created dunes. The 1966 high tides also seriously damaged most of the planted plots.

Hurricane Beulah struck the lower Texas coast on 20 September 1967 and destroyed all the experimental dunes and planting plots near Corpus Christi.

2. EXPERIMENTAL SITES

Four locations were selected to conduct the sand dune experiments. They were the southwest end of Galveston Island near San Luis Pass, Packery Channel and Newport Pass on North Padre Island, and Corpus Christi Pass, the intermittent channel generally regarded as the divide between Padre and Mustang Islands.

The first site, a small area on the southeast end of Galveston Island near San Luis Pass, was chosen mainly because of its convenience to the Galveston District office. The creation of a practical protective barrier was not considered since neither end of the short test section merged into high ground or existing dunes. Northeast of the San Luis site there are some natural nonuniform dunes. These irregular dunes are relatively low, rising slightly more than 5 feet above natural ground.

The test locations on Padre Island were selected to investigate the feasibility of restoring dunes at points where water often passes between the Gulf and the back bay or Laguna Madre during abnormally high tides. Compared to those to the northeast, the dunes on Padre Island are wide and fairly well stabilized, but they are not connected. Padre Island

dunes range from 10 to 30 feet in height, and form a substantial bulwark against hurricane surges, except for those low passes where the dunes are disconnected. All of the four test sites are barren portions of the islands where the land slopes gently from the Gulf shoreline to low crests and then down to the bays. The experiments were all made on land ranging from 2 1/2 to 4 1/2 feet above mean sea level. The diurnal range of tide is 1.2 feet at San Luis Pass and 1.7 feet at Aransas Pass near the Padre Island sites. The maximum tidal range is about 2.2 feet at San Luis Pass and about 2.5 feet at Aransas Pass. The four study areas, designated San Luis Pass, Packery Channel, Newport Pass, and Corpus Christi pass, are shown on Figures 1 and 2.

Wind diagrams for the Galveston and Corpus Christi areas are shown in Figure 3. Analyses of nine random samples taken at various times from the four study areas showed little or no differences in sand size. Ninety percent of the sampled sand ranged from 0.08 to 0.2 mm in diameter. Small sea shells and shell fragments are mixed with the sand. The fine to very fine sand found on the Texas coast is readily transported by normal winds. During periods of light rain and average wind velocities, sand movement has been observed in the study areas. The diagrams show that the prevailing winds are from directions roughly perpendicular to the coastline, which results in movement of the beach sand inland toward the bays.

3. STUDY DESCRIPTION

Creating dunes by the use of junk car bodies instead of conventional wood slat fencing was attempted during the earlier stages of the experiments. It was reasoned that if the car bodies would trap sand, they might also act as reinforcement to stabilize the newly formed dunes. The car bodies were placed in line parallel to the beaches and for a few weeks appeared to be trapping sand in amounts about equal to that trapped by wood slat fencing. However, after an initial accumulation, the rate of entrapment by the car bodies appeared to diminish rapidly, and the total results were obviously less effective than those produced by the wooden fencing. The ground elevations where car bodies were placed originally were generally lower than those where sand fences were placed. Abnormally high tides caused greater damage to sand accumulations in those lower areas. During normal tide periods, natural deposition of beach materials seemed to be generally greater in the lower areas occupied by the car bodies. Because of this natural accreting action, it is probable that sand accumulated in areas up to 50 feet on either side of the car bodies may not be entirely attributable to those barriers. (See Figures 5, 13, and 14.) Car bodies in place are more costly than conventional wood-picket or fabric fencing and apparently trap less sand. Consequently, experiments to build dunes with car bodies have been discontinued by the Galveston District.

Wood picket "snow" fencing was used in most of the sand dune experiments. The fencing consisted of rough cut, square top, yellow pine pickets 3/8 inch thick, 2 inches wide, 4 feet long and woven with five 2-strand

Figure 1. Aerial photograph of San Luis Pass, one of four study areas selected to determine the practicability of creating and stabilizing sand dunes.

Figure 2. Aerial photograph of Packery Channel, Newport Pass, and Corpus Christi Pass, three of the selected study areas.

GALVESTON, TEXAS

CORPUS CHRISTI, TEXAS

WIND DIAGRAMS

CHARTS SHOW PERCENT OF TIME FROM EACH DIRECTION COMPILED FROM U.S. WEATHER BUREAU RECORDS OF HOURLY PREVAILING WINDS AT GALVESTON, TEXAS FOR THE PERIOD 1905 TO 1955 INCLUSIVE AND AT CORPUS CHRISTI, TEXAS FOR THE PERIOD 1905 TO 1948 INCLUSIVE.

WIND DIAGRAM LEGEND

4 TO 15 M.P.H.
 16 TO 31 M.P.H.
 OVER 31 M.P.H.

SAND MOVING WINDS IN THE STUDY AREAS

Figure 3. Wind rose showing sand-moving winds in the four study areas.

cables of 13-gage galvanized wire with 1 1/2-inch spaces. All of the picket fencing was erected on nominal 2 by 4-inch wood posts placed 10 feet on center. For the first sections at San Luis Pass, posts 6 feet long were set 2 1/2 feet deep with the remaining 3 1/2 feet above ground and faced so that the 2-inch side would be parallel to the line of fencing for nailing. Subsequent sections in the Corpus Christi area were erected on posts 5 feet long, set 2 feet in the ground, with the 4-inch width faced to receive the fencing. These post settings were more economical and provided a wider, more rigid nailing surface. Extension of the slat fencing 1 foot above the top of the posts had no adverse effect on the stability of the fence.

A second tier of fencing was placed on top of the original wood picket fence in the Packery Channel area about 4 months after installation of the initial fence and after the dunes had formed to about 3 1/2 feet above natural ground. The second tier fencing was comprised of about 150 feet of polyethylene plastic material with 5/8-inch mesh and a porosity of 82 percent, about 150 feet of 1/4-inch mesh plastic material with a porosity of 68 percent, and about 100 feet of wooden picket fence for comparison purposes.

Soon after installation, portions of the three added sections were blown down or destroyed by vandalism, and no surveys were made to determine comparative sand volume accumulations. Observations did indicate that fabric fence with the lower porosity trapped more sand than fabric with high porosity, and that the wood picket fence trapped more than either of the fabric types.

Additional information of the fabric type fencing may be found in a paper by Savage and Woodhouse. (Savage, R. P. and Woodhouse, W. W. Jr., 1968, "Creation and Stabilization of Coastal Barrier Dunes", a paper published in Proceedings of the 11th Conference on Coastal Engineering, ASCE, held in London in 1968.)

Table I shows average volumes of sand accumulated by the various fences at the four experimental areas. Locations of the typical sections correspond with the lengths in feet on plans shown on Figures 4 through 14. Although the table reflects average volumes for fence sections of several hundred feet, some smaller sections of about 100 feet in length accumulated up to 16.1 cubic feet of sand per linear foot of fence.

4. VEGETATION

Efforts were made to establish grass to accelerate sand accumulation and stabilize parts of new dunes in the San Luis Pass, Packery Channel, and Newport Pass areas. Five 30- by 100-foot and six 40- x 50-foot plots were sprigged or seeded in the San Luis Pass area and seventeen 40- by 100-foot plots were sprigged or seeded in the two areas near Corpus Christi. The planting was done during December 1965 at San Luis Pass and during March 1966 at Packery Channel and Newport Pass. Some plots were sprigged

TABLE I

TYPICAL SAND ACCUMULATIONS*

Area	Station Location**		Fence Type	Initial Installation Date	Cubic Yards Sand Accumulated per linear foot of beach, as of:			
	From:	To:			Sep 65	Dec 65	Oct 66	May 67
San Luis Pass	0	500	Car Bodies	May 65	1.3	3.6		3.7
	500	1000	Picket Fence	Apr 65	1.4	3.5		4.4
	1000	1250	Picket Fence	Apr 65	1.4	1.8		3.7
	1250	1500	Picket Fence	Apr 65	0.7	1.0		3.6
Packery Channel	0	600	Picket Fence	Nov 65			Oct 66	
	600	1300	Picket Fence	Nov 65	1.0	6.2		10.5
	1300	1800	Picket Fence	Nov 65	1.1	6.0		12.2
Newport Pass	0	800	Picket Fence	Nov 65	1.0	5.3		7.0
	800	1200	Picket Fence	Nov 65	2.0	6.3		10.5
	1200	1700	Picket Fence	Nov 65	2.5	7.5		13.7
	1700	2000	Picket Fence	Nov 65	1.9	6.1		12.6
Corpus Christi Pass	0	240	Car Bodies	Nov 65	1.3	5.3		9.6
	240	550	Car Bodies	Sep 65	3.0	3.0		5.5
	550	963	Car Bodies	Sep 65	2.2	3.6		5.1
				Sep 65	1.1	4.9		6.5

* In cubic yards per linear foot of beach.

** Distance in feet from 0 end of fence.

with spartina and American beach grass plants and salt cedar cuttings. Other plots were seeded with buffel grass, little bluestem, big bluestem, switch grass, sand dropseed, and weeping lovegrass. Sprigged plants appeared to survive well, and seeds produced an average crop of sprouts soon after planting. Unfortunately, abnormally high tides during May 1966 covered the test plots, and destroyed most of the plants. Some American beachgrass did survive the high water, but was later killed by blowing sand and drought during the summer of 1966. The only experimental plants that still survive are some spartina (marsh hay cord grass) which were sprigged behind protective dunes in the San Luis Pass area. Considering the time, effort, and funds expended in attempts to establish vegetation on the new dunes and low beaches, the results were disappointing.

5. SUSPENSION AND RESUMPTION OF EXPERIMENTS

Reducing funding and imposed limitations on the scope of the work under the Texas Coast Hurricane Flood Protection Studies made it necessary to suspend sand dune experiments during the latter part of 1966. In September 1967, high water and waves from Hurricane Beulah completely destroyed all three of the newly formed, unstabilized, experimental dunes in the Corpus Christi area. As late as April 1969, some water was still passing between the Gulf of Mexico and Laguna Madre through Packery Channel, Newport Pass, and Corpus Christi Pass. The experimental dunes in the San Luis Pass area were partly destroyed by Hurricane Beulah and later washed away by high tides and waves caused by the unusual Gulf Coast Storm of 13 and 14 February 1969.

During the initial study, it was learned that substantial dunes can be created in a short time on a large part of the Texas coast. There are also indications that certain plants might effectively create and stabilize sand dunes if conditions are favorable until they are established.

These first experiments show further efforts should be made to determine the most desirable means of trapping windblown sands with fences, and of propagating grasses for trapping and stabilizing sand. Experiments were resumed in February 1969 on South Padre Island near Port Isabel, Texas, under a cooperative program. Participants in the current program include the Coastal Engineering Research Center (CERC), the Gulf Universities Research Corporation (GURC), and the Galveston District.

6. CONCLUSIONS

The use of junk car bodies to build sand dunes is not recommended. It appears that the overall porosity of car bodies placed end to end in a line is too dense and somewhat alters the direction of sand-carrying winds. One section of car bodies at Corpus Christi Pass accumulated an average of 4.9 cubic yards of sand per linear foot of beach. During the same period, a single line of picket fence at nearby Newport Pass accumulated an average of 5.3 cubic yards per linear foot of beach. Based on the cost of car bodies in place (\$1.00 per linear foot) as compared to

picket fencing installed (\$0.50 per linear foot), the cost of sand accumulated by the car bodies averaged about 85 percent more than the cost of sand accumulated by the single picket fence.

Additional studies should be made to determine the most practical plan for erecting additional sand fences after sand has nearly or completely covered the original fence. A 4-foot fence installed directly on top of the original fence produced dunes of high peak elevation, but with a relatively narrow base or foundation (see Figure 8). It was difficult to dig post holes in new, soft, unstable sand to install a second fence, 6 to 10 feet behind the first (see Figures 5 and 11). The feasibility of installing a fence, approximately 30 feet in front of the original fence after it has been nearly covered, should be considered. Further experiments should be planned to determine the feasibility of this plan for increasing the size of the dune (see Figure 10). The best time for adding new fences under any of the three most likely plans should be established during further experiments. Sand volume accumulations from the second fence, whether installed on top of, behind, or in front of the original fence line, were about equal. Maintenance of sand fencing is important to produce valid data on sand accumulation for comparison of various types and schemes of fencing. In addition, different sand fence materials should not be used together in any one particular test section, as was done in some of the first experiments. (See Figure 6, stations 100 to 600, where plastic mesh fence was installed on top of wood picket fence.) In such instances, it was impossible to distinguish the amounts contributed by the various types of fencing.

Results from the experiment indicate that fencing materials with porosities of 40 to 60 percent produce the best results for conditions on the Texas coast. Further tests should show which materials and porosities within that 20 percent range will be most efficient.

The limited experiments with vegetation showed that rapid sand accretion near sand fences smothered certain plants. In other cases erosion exposed roots of plants before they became established. Based on the meager results of these tests, it appears that the more salt-, wind-, and drought-tolerant native beach grasses will be the most productive in future planting experiments, especially on the arid Padre and Mustang Islands of the Texas coast.

If possible, experimental planting and sand fence construction should be located on beaches at least 2 feet above mean high tide to minimize probable damaging effects from higher astronomical tides during the equinox and surges generated by normal winds.

Many photographs were taken during the dune experiments. A selection of typical views are Figures 15 through 33. References to station locations in the captions of the pictures are the same as the lengths in feet shown on plans of Figures 4 through 14.

Figure 4. Sand-fence installations and resulting dunes at San Luis Pass. See Figure 5 for detailed sections at Stations 3+00 and 7+00 (shown by asterisks).

Figure 5. Sand accumulation at San Luis Pass. See Figure 4 for section locations.

Picket Fence Installed November, 1965

5/8" Mesh (Polyethylene) Fabric, 82% Porosity Installed Similar to Section B-B, March 1966, But Without Guy Wires

1/4" Mesh (Polyethylene) Fabric, 68% Porosity Installed Similar to Section B-B, March 1966, But Without Guy Wires

Picket Fence Installed Similar to Section B-B March 1966 But Without Guy Wires. Blown Down After 2 Weeks.

Repaired October, 1966 With Guy Wires

Picket Fence Installed October, 1966

Figure 6. Sand-fence installations and resulting dunes at Packery Channel. See Figure 7 for cross section at station 7+00 and Figure 8 for cross section at station 13+00; both stations shown above by asterisks.

Figure 7. Sand accumulation at station 7+00 at Packery Channel.
Location of station shown on Figure 6.

Figure 8. Sand accumulation at station 13+00 at Packery Channel. Location of station shown on Figure 6.

— Picket Fence Installed November, 1965
 - - - Picket Fence Installed October, 1966

Figure 9. Sand-fence installations and resulting dunes at Newport Pass.
 Cross sections of stations 8+00 and 14+00 (indicated by asterisks) are shown in Figures 10 and 11.

Figure 10. Sand accumulation at station 8+00 at Newport Pass. Location of station shown on Figure 9.

Figure 11. Sand accumulation at station 14+00 at Newport Pass. Location of station shown on Figure 9.

Figure 12. Car-body and sand-fence installation at Corpus Christi Pass. Cross sections of stations 3+60 and 6+60 (indicated by asterisks) are shown in Figures 13 and 14.

Figure 13. Sand accumulation at station 3+60 at Corpus Christi Pass.
Location of station shown in Figure 12.

Figure 14. Sand-fence installation at Corpus Christi Pass. Location of station shown on Figure 12.

Figure 15. San Luis Pass - April 1965 - From Station 1500 looking SW, showing first test fence during construction.

Figure 16. San Luis Pass - May 1965 - from Station 500. One half of car bodies in background placed on their sides.

Figure 17. San Luis Pass - September 1965 - From Gulf side showing sand accumulation after about 14 weeks.

Figure 18. San Luis Pass - October 1965 - From about Station 750, looking NE at recently sprigged native spartina grass.

Figure 19. San Luis Pass - August 1966 - from about Station 800 looking NE, showing sand fence accumulation which covered most of spartina grass shown in Figure 18. See cross section 7+00, Figure 5.

Figure 20. San Luis Pass - August 1966 - Looking SW. Compare with Figure 15. San Luis Pass Bridge in right background.

Figure 21. Packery Channel - July 1965 - Looking NE toward proposed fence alignment.

Figure 22. Packery Channel - July 1966 - From about Station 470 looking NE, showing sand accumulation 8 months after installation of initial fence. Plastic fence added March 1966 appears to effect dune shape but not sand volume. See Figure 7.

Figure 23. Packery Channel - July 1966 - From Station 1800, looking SW. Spartina grass plot at left middle planted March 1966.

Figure 24. Packery Channel - October 1966 - Same as Figure 23. Only about 10 percent survival of spartina grass plot at left of fence.

Figure 25. Packery Channel - April 1967 - Looking SW from about Station 1700. Second lift fence installed October 1966 at middle left. See Figure 8.

Figure 26. Newport Pass - March 1966 - Plot of American beachgrass just after planting.

Figure 27. Newport Pass - July 1966 - Same as Figure 16, showing survival of American beachgrass after 4 months.

Figure 28. Newport Pass - July 1966 - Looking SW from about Station 1300 showing fence constructed 30 feet west of base fence which has no effect on dune. See Figure 11.

Figure 29. Newport Pass - April 1967 - Looking SW from Station 1600.
See Figure 11.

Figure 30. Corpus Christi Pass - July 1965 - Looking NE across Pass,
showing proposed alignment of car bodies.

Figure 31. Corpus Christi Pass - September 1965 - Same as Figure 30 just after placing car bodies.

Figure 32. Corpus Christi Pass - September 1965 - Looking northwest at NE end just after placing car bodies.

Figure 33. Corpus Christi Pass - March 1966 - Same as Figure 32
6 months later. See Figure 14.

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	Junk car bodies						
	Texas						

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