The Effect of Wrack on Sand Transport

on a Lake Michigan Dune System

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Abstract

Foredunes are a very abundant landform along Lake Michigan, and there are many factors that cause these dunes to change. Our study investigated wrack: the organic matter that waves deposit on the beach. We investigated the accumulation of wrack, how it affects sand transport, and how it contributes to foredune construction and growth. Our study was located on a beach and foredune in P.J. Hoffmaster State Park on the coast of Lake Michigan. The methods included GPS, erosion pins, sand traps, visual observations, sand samples for moisture content, and wrack characteristic analysis. The beach was divided into two sections, one that was raked weekly (Site A), and one that was left alone (Site B). We measured more sand transport on Site A, the site without wrack, than Site B, the site with wrack. The sand trap data indicates that the amount of sand that can pass through wrack is greatly decreased compared to open beach. This can cause increased deposition on the foredune.

Introduction

Wrack is critical for stable beach ecosystems and is also a factor in the sand transport by wind from beaches to dunes [1, 2, 3] . Multiple studies have been conducted regarding the influence of wrack on foredunes on ocean coasts, but wrack on lake coasts has never been directly analyzed.

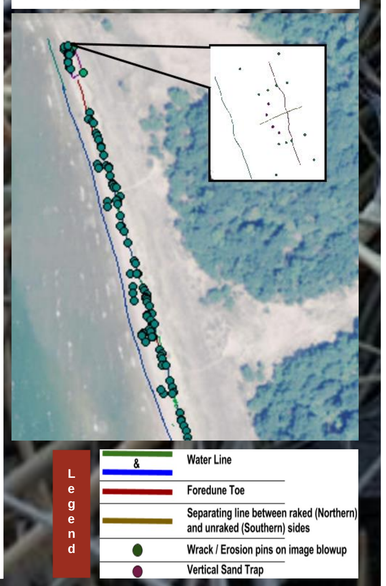
Objectives:

- Examine characteristics of Lake Michigan wrack
- Investigate relationship between wrack and sand transport, erosion/deposition, and moisture
- Determine effects of wrack on beach and foredune

Study Area

Our study area was at PJ Hoffmaster State Park – on the beach and foredune (Figure 1) . We marked off an area of beach, reaching back to the crest of the foredune, 20 meters long but divided into two 10-meter plots for studying (Figure 1 inset). Testing equipment was placed at strategic locations within this area.

Figure 1. The study area was located in P.J. Hoffmaster State Park.



Methods

Our main experimental site was partitioned into two equal parts - one maintained in its natural state, the other deprived of wrack; two vertical sand traps and four erosion pins were placed in both sections (Table 1). Over two weeks, one set-up day and two measurement visits were made to Hoffmaster State Park to measure the amount of sand in sand traps, height of sand by erosion pins, and amount of moisture. We also mapped wrack and documented its characteristics on a stretch of beach north and south of our experimental site.

Equipment	Purpose
Erosion Pins	To determine levels of erosion and deposition
Sand Traps	To determine quantities of sand transport
GPS / GIS	To map wrack, foredune, waterline, and equipment placement
Moisture Tins	To analyze sand moisture levels

Table 1. Different tests performed and the functions and objectives related to each test.

Results

Sand Transport Patterns

The vertical sand traps in the raked area collected 18.60 times the sand as those surrounded by wrack.

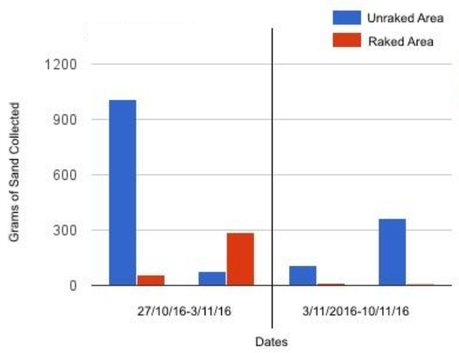


Figure 2. Data collected by sand traps over the two-week collection period. Note-the third bar in Figure 2 displays a flawed collection. The vertical sand trap in the wrack had a large hole in the bottom; hence the lower data comparison.

Moisture Content

The moisture content data was inconclusive (Figure 3). The data shows little to no correlation between wrack and moisture content.

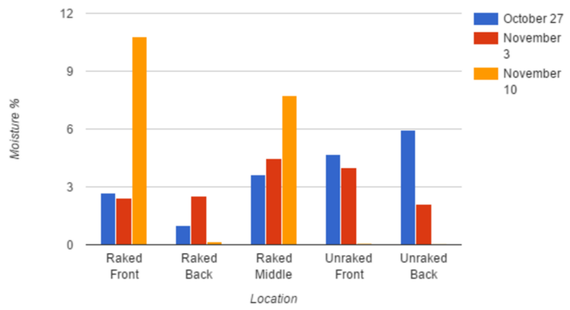


Figure 3. Data collected through moisture content tests.

Erosion and Deposition

The raked side had less deposition than the unraked side (Figure 4). Wrack observed around erosion pin two on the unraked side could be the cause of deposition. Nov. 3 had a more prominent difference between sides than Nov. 10.

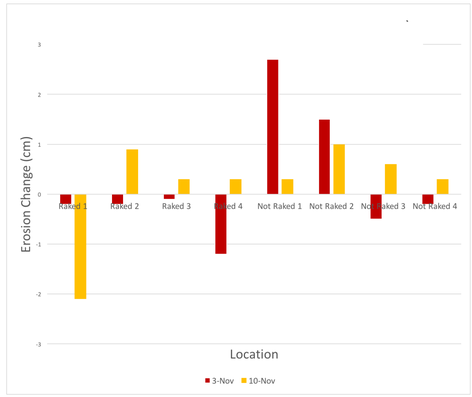


Figure. 4 Displays erosion change on Nov. 3 and Nov. 10 at eight different locations on the raked and unraked sides of the study site. Erosion is indicated by a negative change and deposition by a positive.

Wrack Characteristics

On the unraked side, wrack was in large mounds (Figure 5) and consisted of primarily dead beach grass, driftwood, feathers, zebra mussels, cattails, and cultural debris such as Styrofoam, bottle caps, and ribbon. The raked side was similar in composition with smaller driftwood and more dispersed debris. After it was raked and observed in the coming weeks, little wrack washed up, only a scattering of dead beach grass and a few deposits of wrack. We also observed that if there was scarp in places with wrack, the wrack tended to touch the scarp, whereas if there was no scarp wrack would form a line on the beach and there would be more of it.

Discussion

The sand trap data indicates that wrack hinders sand transport on the foredune and upper beach. The traps behind the wrack line had significantly less sand in them compared to the traps on the raked beach (Figure 5).

Studies show that long term raking of beaches can cause the foredune to retreat away from the coast line [1]. We observed sand accumulating around the wrack on the beach which helps stabilize and increase the foredune toe, confirming what other studies have concluded [2].

Deposition occurred more frequently on the side with wrack (see Figure 4) because the barrier of the wrack causes sand transport to slow and deposit within the wrack whereas the beach with no wrack causes sand to be transported and eroded because of the absence of barriers. This phenomenon fluctuates with weather, wind speed and direction.

Figure 5. Wrack on portion of the study area at Hoffmaster State Park. Note the erosion pin and sand trap placement.

Conclusions

We found that wrack has noticeable effect on sand transport. Removing the wrack through beach raking resulted in more sand movement. We also found evidence that wrack can cause deposition in and immediately after the wrack resulting in less deposition in the foredune. The absence of wrack results in an increase of foredune erosion.

Acknowledgements

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References

[1] Conaway, C.A. and J.T. Wells. (2005). “Aeolian Dynamics along Scraped Shorelines, Bogue Banks, North Carolina.” *Journal of Coastal Research* 21: 242-254.
[2] Jackson, N. L. and K.F. Nordstrom. (2013). “Aeolian Sediment Transport and Morphophologic Change on a Managed and a Unmanaged Foredune.” *Earth Surface Processes and Landforms* 38: 413-420.
[3] Nordstrom, K.F, K.H. Korotky, and N.L. Jackson. (2011). “Aeolian Sediment Transport Across Beach Wrack.” *Journal of Coastal Research* 59: 211-217.