

# Indicators of Erosion and Deposition within a Coastal Dune System

Robin L. Gelderloos, Kathryn E. Mollison, and Kaitlyn E. Westra

## Abstract

Lake Michigan coastal dunes provide a location to study dune sediment budgets and to look at the transport of sand in various areas. Our study investigates the areas of sediment movement on Dune 2 in P.J. Hoffmaster State Park and aims to find indicators of sediment erosion and deposition that can be applied to other dune systems. We measured the amount of sand movement with erosion pins, used GPS data to map landform units, and used vegetation measurements to evaluate its influence on erosion and deposition. In general, areas of bare sand were indicators of erosion. The data also show erosion on windward dune slopes and deposition on leeward slopes. Our study has evaluated the viability of using these indicators to determine erosion and deposition areas, showing that this method can be applied to other coastal dunes, especially those in environments similar to the coast of Lake Michigan.

## Introduction

Erosion on sand dunes is often discussed, but the sediment budget of dunes can be easily overlooked. While a certain amount of sediment movement forms dunes [1], our research aimed to see how topography and vegetation indicate erosion and deposition in dune systems. We wanted to define a sediment budget cell on Hoffmaster State Park's Dune 2, finding the main source and sink areas. Our objectives were:

- to predict and measure areas of deposition, erosion, and stability
- to record and analyze the vegetation in these areas.

## Study Area

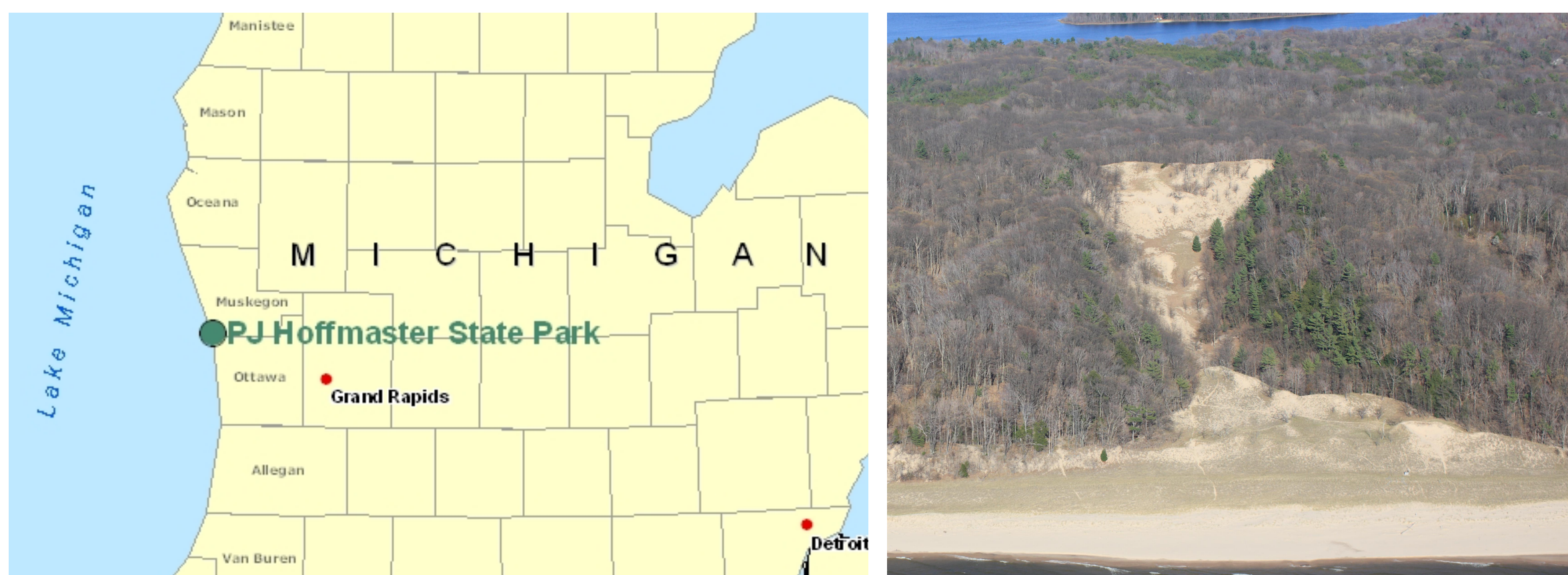


Figure 1: The location of the State Park in relation to the coast of Lake Michigan, [ilovesleepingintents.com](http://ilovesleepingintents.com)



Figure 2: An oblique aerial view of Dune 2, [U.S. Army Corps of Engineers 2012](http://www.usarmy.com).

We conducted our research at P.J. Hoffmaster State Park (Figure 1) on Dune 2 (Figure 2), from the foredune through the slipface of the main dune.

## Methods

Measured Variable	Method
Predicted areas of erosion, deposition, and stability	Use GPS unit to map
Surface Change	Measure with erosion pins
Vegetation Density	Counted plants within quadrats

Table 1: Describes methods used to accomplish objectives

We used indicators to predict how sediment would move before we measured surface changes and vegetation characteristics (Table 1).

## Results

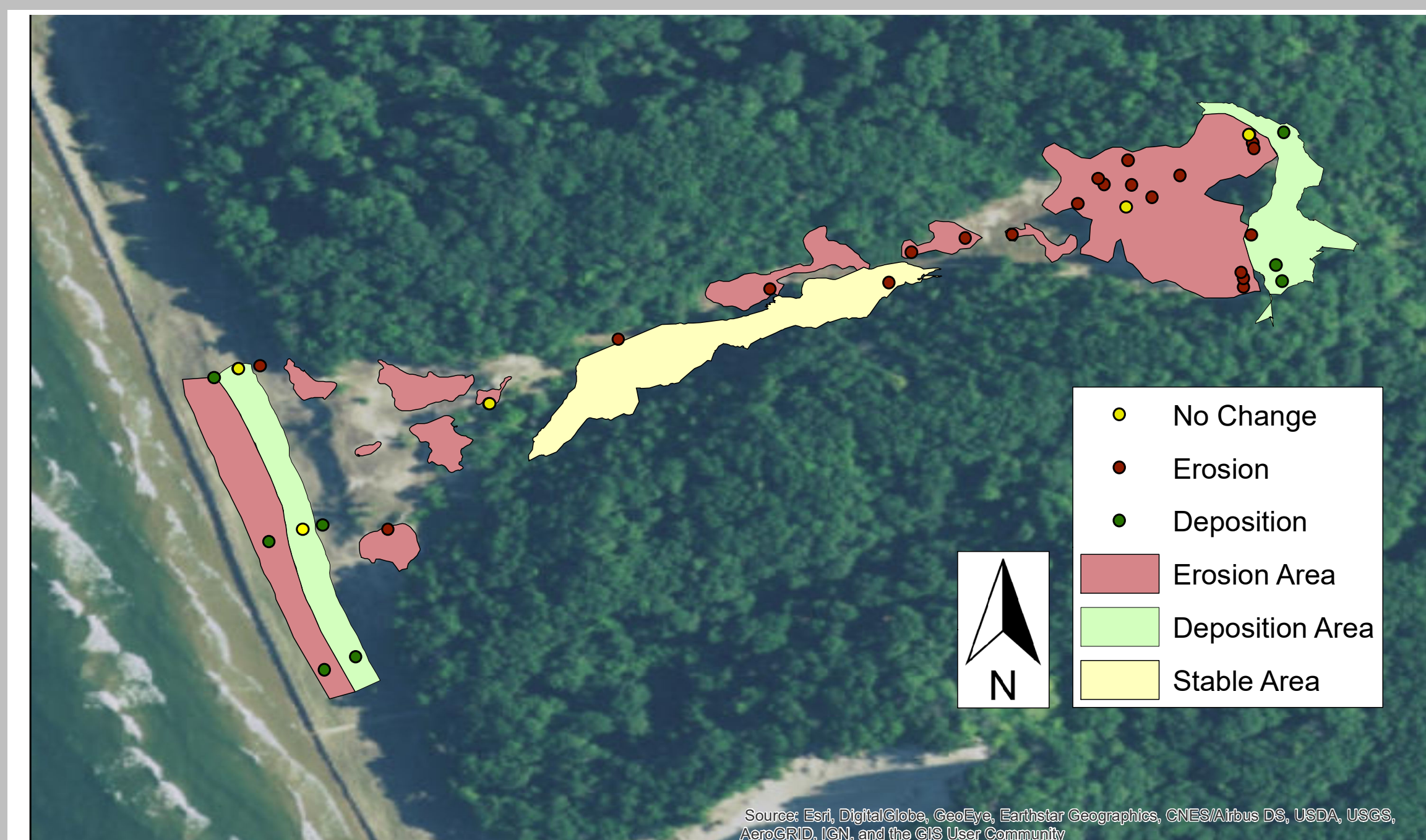


Figure 3: Shaded areas predicted prior to the study, along with recorded data from erosion pins

Our predictions showed erosion and deposition areas on the foredune and blowouts in the parabolic dune, with a large area of stability in the center of the dune (Figure 3).

Measurements showed deposition on the foredune and slipface, stability in the dune ridge trough, and erosion from the dune ridge crest to the slipface (Figure 3).

Dune Area	Average Number of Plants	Direction of Sediment Movement
Windward Foredune	15	deposition
Leeward Foredune	7.67	erosion
Foredune Trough	6	deposition
Dune Ridge	7.6	erosion
Main Trough	3.83	erosion

Table 2: Average plant density in each designated dune area, and direction of sediment transport

The highest level of vegetation is on the windward foredune because it is covered entirely with dune grass, whereas the lowest level of vegetation is in the main trough (Table 2). This area is composed mainly of larger trees and leaf cover which is more stabilizing than grass.

## Discussion

As expected, the blowouts were an indicator of erosion due to being on the windward slope and to their lack of vegetation. Additionally, results suggest that there was a significant deposition area at the slipface, which we correctly predicted based on other studies' measurements of wind in relation to topography [2]. Thus, there is an overall pattern of a sediment budget cell from the foredune crest, the source, to the slipface, the sink.

## Conclusions

The most erosion occurred in blowouts and in places that had little to no vegetation. However, the opposite was not always true as the vegetated areas had a significant amount of erosion where we predicted stability or deposition.

Our measurements did not affirm all of our predictions for this study. Areas with vegetation are difficult to predict and require further study. Nonetheless, we hope our findings will guide future research on sediment budgets throughout dunes.

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## References

- [1] Zhang, W., R. Schneider, J. Kolb, T. Teichmann, J. Dudzinska-Nowak, J. Harff, and T. J.J. Hanebuth. 2015. "Land-sea interaction and morphogenesis of coastal foredunes — A modeling case study from the southern Baltic Sea coast." *Coastal Engineering* 99: 148-66.
- [2] Bauer, B. O., P. A. Hesp, I. J. Walker, and R. G.D. Davidson-Arnott. 2015. "Sediment transport (dis)continuity across a beach-dune profile during an offshore wind event." *Geomorphology* 245: 135-48.