

# Alongshore Measurement of Beach Width as an Indicator of Fore-dune Erosion

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## Abstract

The beach fore-dune system alongshore of Rosy Mound Natural Area, Hoffmaster State Park, and Muskegon State Park provide locations to study beach width and its effects on erosion. Our study mapped the dune-beach boundary and the shoreline to determine the utility of beach width as an indicator of fore-dune erosion. GPS Trimble units were used to map the beach-fore-dune system. In each location, we measured certain aspects of the fore-dune-beach system, such as scarp height, the slope of the scarp, and the distance from the scarp to the lake. The results show that there is a correlation between beach width and fore-dune erosion. The most common trend observed was that a higher fore-dune can be an indicator of a narrow beach width. This research will increase the understanding of how sediment budgets of the fore-dune beach system can be affected by wave erosion.

## Introduction

Little investigation has been done into the relationship between the dune-beach boundary and the environment's effects on sediment budget, especially within the state of Michigan. Research from other locations have indicated that beach width influences sediment transport on the fore-dune [1]. Our study investigates the relationship between beach width and fore-dune erosion along the shores of three parks on the west coast of Michigan.

Our study objectives were to:

- Map the dune-beach boundary and the shoreline in three dune areas
- Measure characteristics of the fore-dune-beach system, including fore-dune height/slope and the width of the beach

## Study Areas

The study took place along the beach-fore-dune system in Rosy Mound Natural Area, Hoffmaster State Park, and Muskegon State Park [Fig 1], which are all located along the east coast of Lake Michigan.

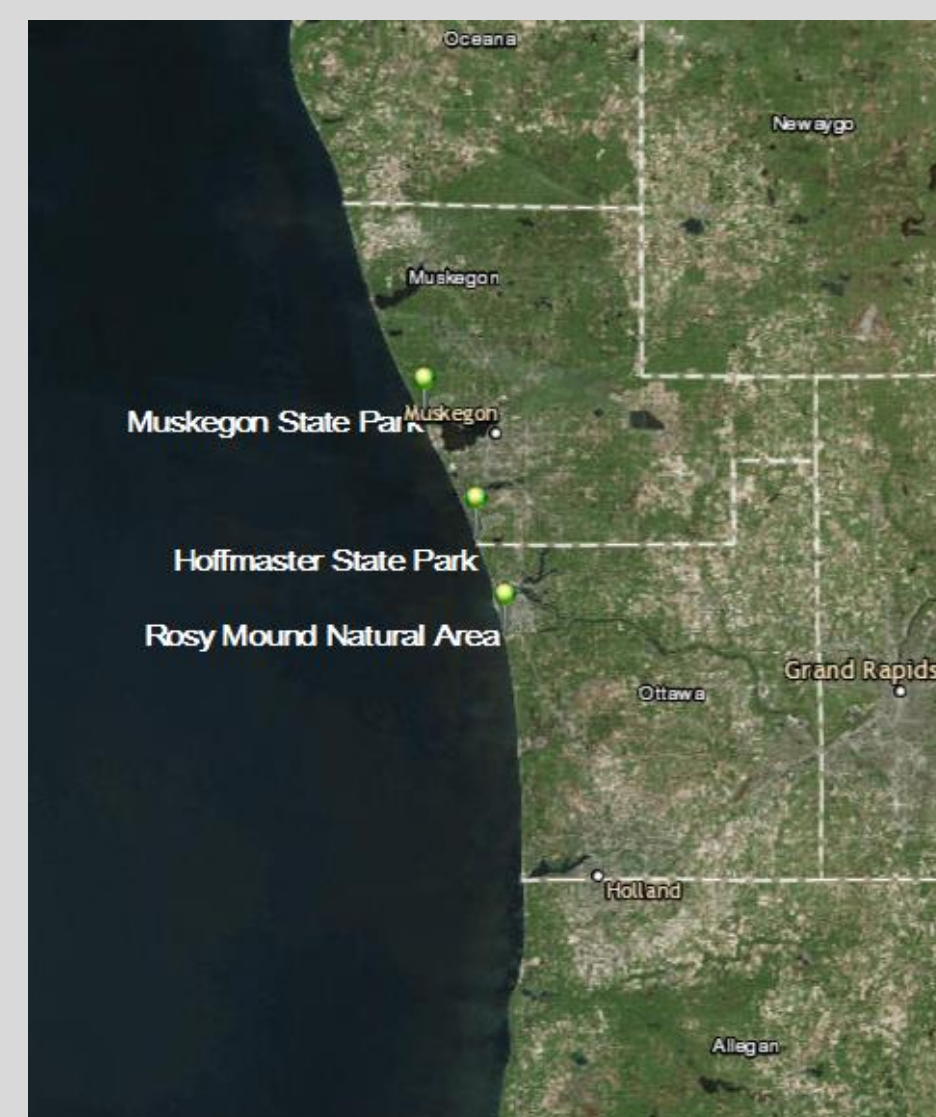


Figure 1: Study areas along coast of Lake Michigan

## Methods

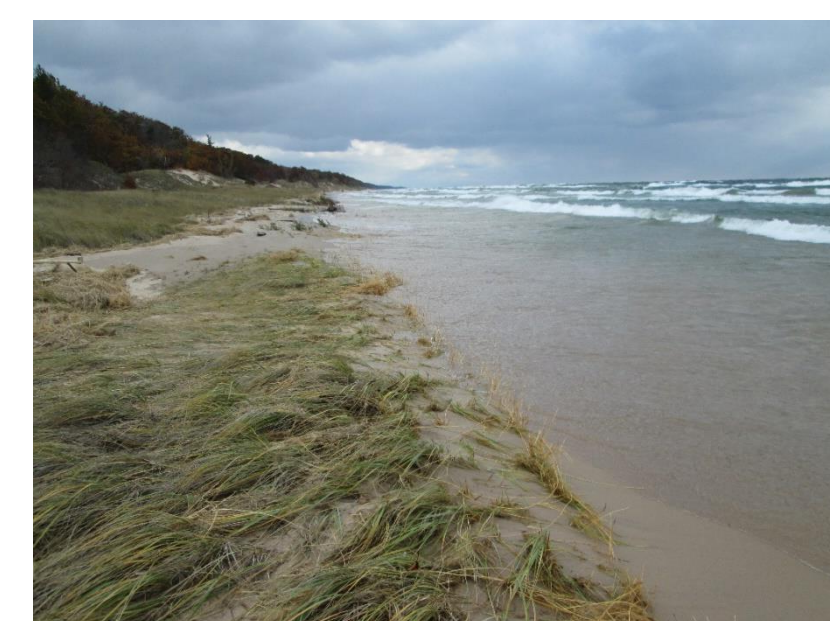
### Alongshore Characteristics

We mapped the dune-beach boundary and the beach-lake boundary along the coastline in our study areas. We mapped segments along each coastline where there was similar scarp height. In the rough midpoint of each segment, we measured scarp height (using a stadia rod), scarp slope (using a level), and beach width (using a tape measure).

### Scarp Heights

Sections of shoreline were categorized by varying scarp heights [Fig 2,3].

Below: Figure 2: Varied scarp heights along Lake Michigan's coast in each study area



A) Low scarp in Hoffmaster State Park



B) Medium scarp in Rosy Mound Natural Area



C) High scarp in Muskegon State Park



D) No scarp in Hoffmaster State Park

Scarp Height	Category
No scarp	0m
Small Scarp	0-0.8m
Med Scarp	0.8-1.4m
High Scarp	1.4m+

Figure 3: Categorization of scarp heights

## Results

We observed in Muskegon State Park and Hoffmaster State Park that the beach-fore-dune boundaries had more areas of no or low scarp than high scarp areas. Rosy Mound Natural Area differed in that it featured more areas of high scarp.

Figure 4: Map of Muskegon State Park study sections with varying scarp heights and shoreline



The data shown below [Fig 5, 6, 7] displays a moderate correlation in scarp height to beach width. The trendline of the graph from both Muskegon and Hoffmaster State Parks indicate that as scarp height increases, beach width decreases.

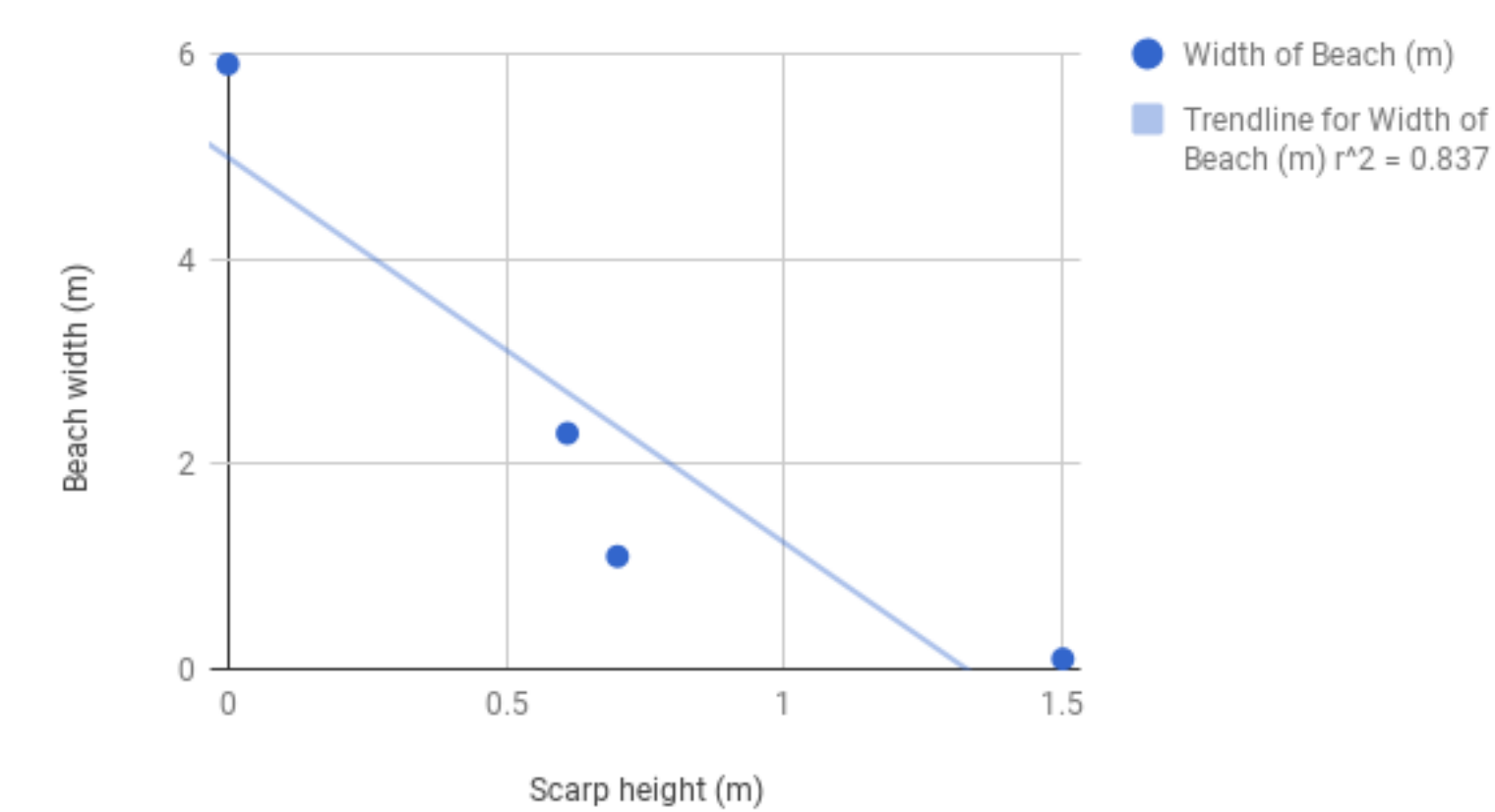


Figure 5: Beach width and scarp height in Hoffmaster State Park

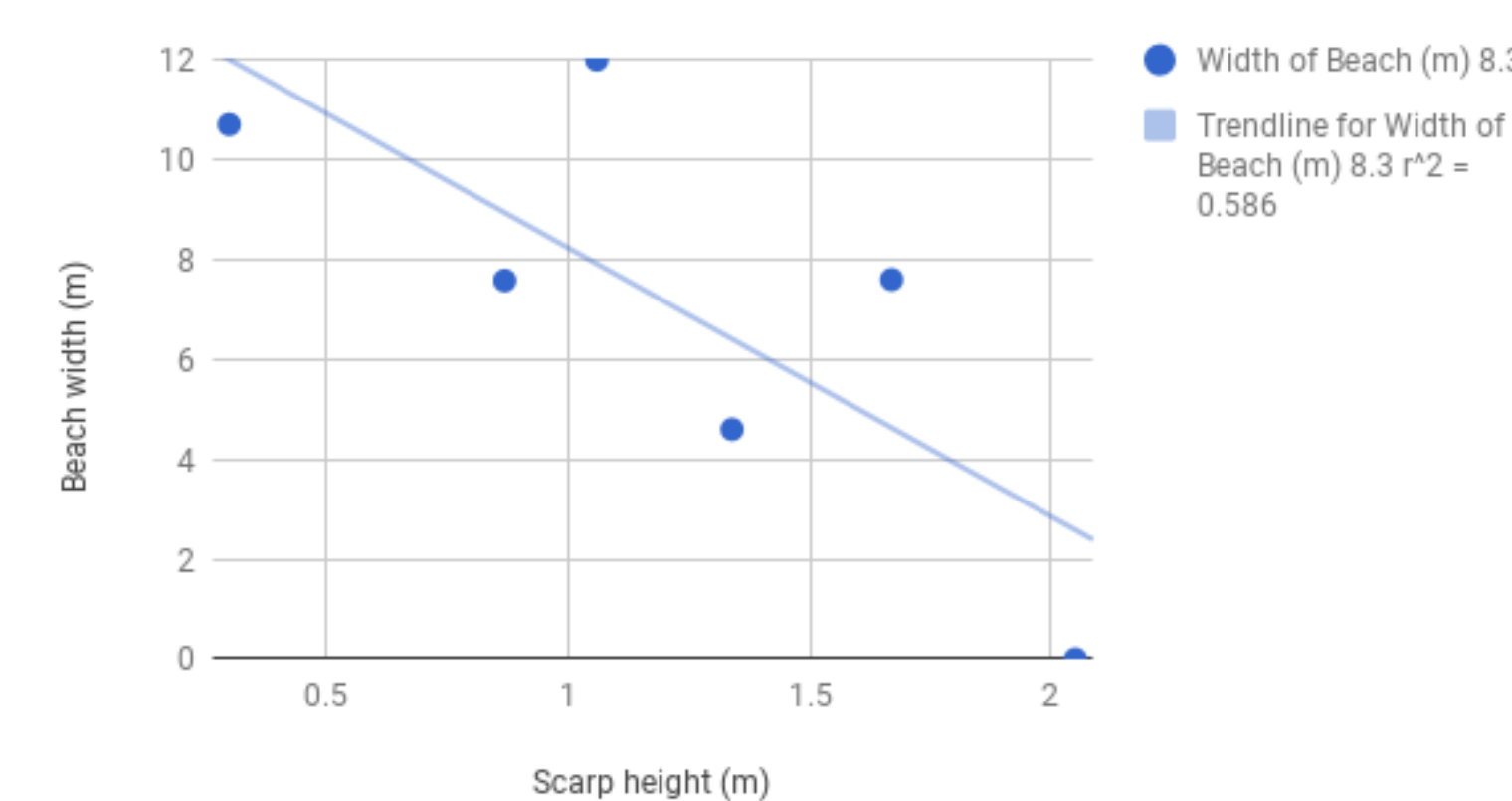


Figure 6: Beach width and scarp height in Muskegon State Park

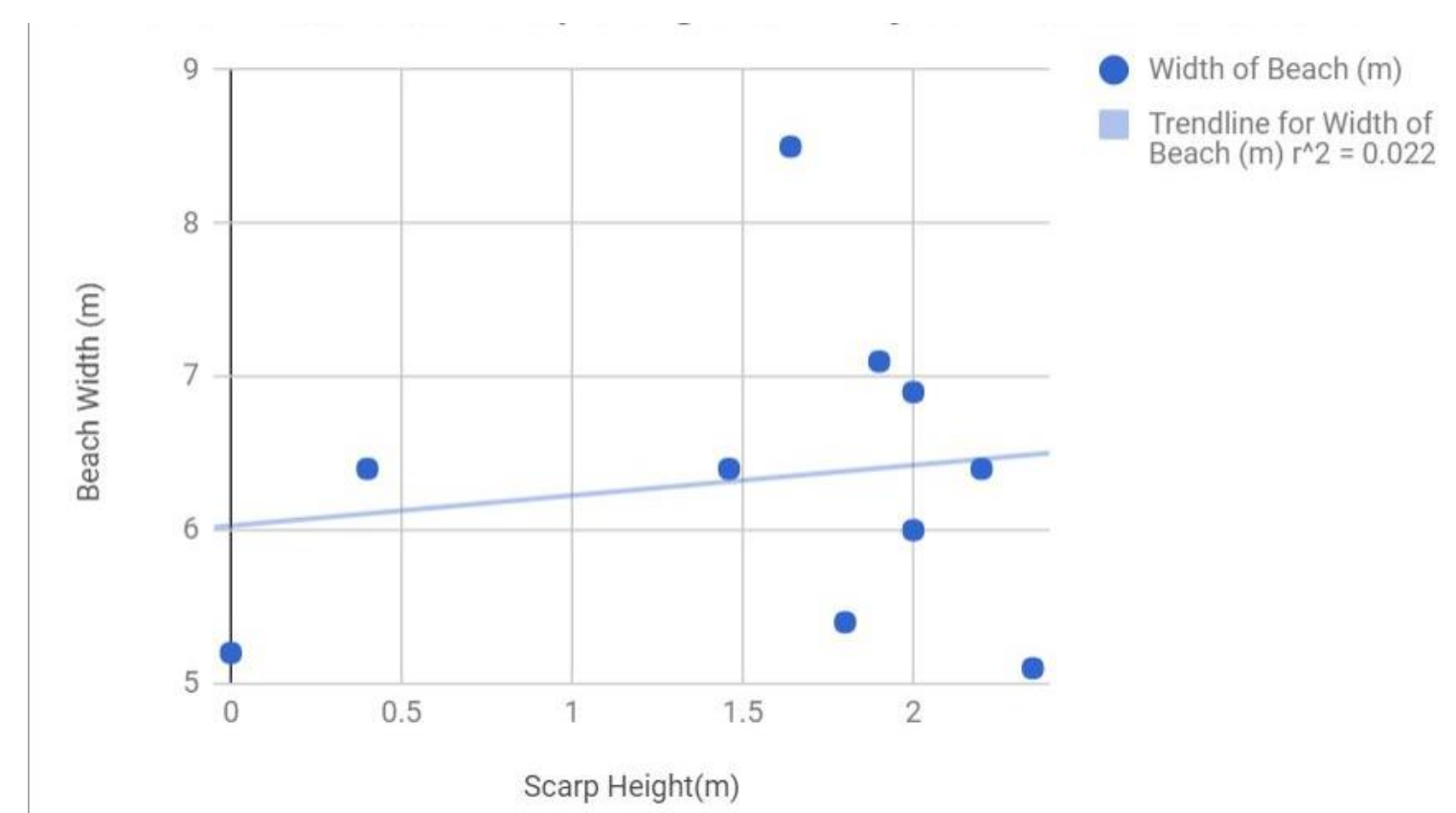


Figure 7: Beach width and scarp height in Rosy Mound Natural Area



Figure 8: Low scarp and wide beach in Muskegon State Park

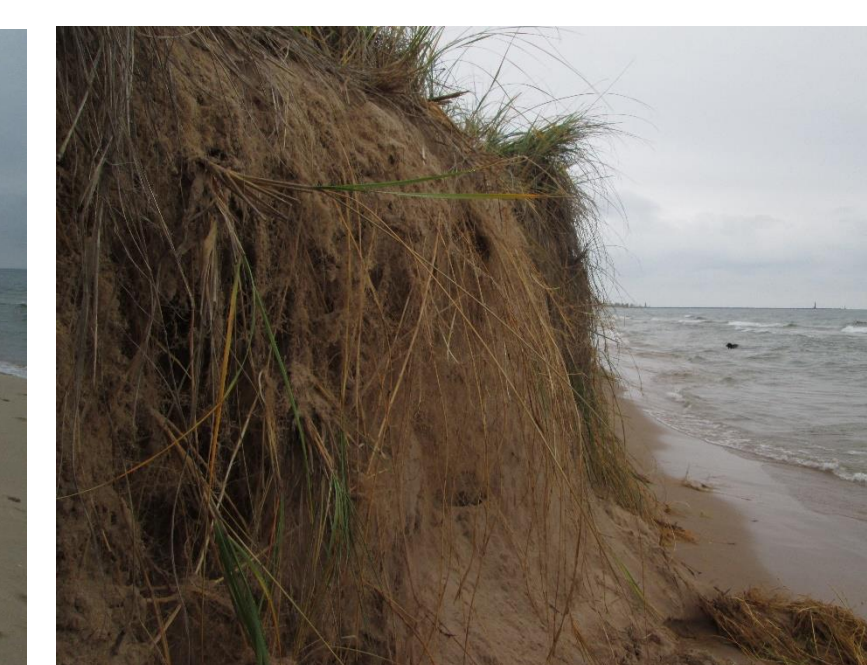


Figure 9: High scarp and narrow beach in Muskegon State Park

The correlation in our results can be seen above in two segments of our study area in Muskegon State Park on the east coast of Lake Michigan, where low scarp (<0.8m) is present with a wide beach [Fig. 8], and where high scarp (1.4m+) is present with very narrow beach width [Fig 9].

## Discussion

Contrarily, Rosy Mound does not share this correlation [Fig. 10], which could potentially be due to increased human impact in that park. Additionally, there may simply be less of a correlation than indicated by the data initially.



Figure 10: High scarp with wide beach at Rosy Mound

The severe weather conditions that took place during measurements at Hoffmaster State Park and Muskegon State Park could have influenced our data collection. Previous studies suggest that severe weather leads to a significant increase of erosion [2].

## Conclusion

The data seems to show that along the east coast of Lake Michigan, there is a mild correlation where regions with higher scarps were frequently associated with narrower beaches. Future studies will be able to use the data we collected during a different season with fewer storms to see the changes in morphology and the fore-dune-beach relationship.

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## References

- [1] Davidson-Arnott, Robin G.D. and Mark N. Law. 1996. "Measurement and Prediction of Long-Term Sediment Supply to Coastal Fore-dunes." *Journal of Coastal Research* 12(3): 654-663.
- [2] Suarez, Serge, Jean M. Cariolet, Romain Cancouet, Fabrice Arduin, and Christophe Delacourt. 2011. "Dune recovery after storm erosion on a high energy beach: Vougot Beach, Brittany (France)." *Geomorphology* 139-140: 16-33.