

The Relationship between Human Impact and Scarping with the Characteristics of *Ammophila Breviligulata* on Foredunes

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Abstract

The American beach grass, *Ammophila breviligulata*, is an important pioneering species abundant on the foredunes of Lake Michigan. We studied the relationship between scarping, human influence, and *A. breviligulata* the foredunes in Hoffmaster State Park. During the two week study, data was carefully collected from three study sites: a site with human impacts, a control site, and a site with significant scarping. The main form of data collection used was 0.5 by 0.5 meter quadrats thrown randomly five times per location (scarp/windward slope, crest, and leeward slope of each study site) to collect the height, density and health data for *A. breviligulata*. Our data suggest that the health of *A. breviligulata* at our study sites was greatest at the control, followed by the site with human impacts and then the site with significant scarping. The effects of human influences on a foredune negatively impact the vegetation. However the effects scarping has on the vegetation are not as clear. Further research should be done on the effects scarping has on foredune vegetation.

Introduction

Several recent studies examine the relationship between foredune vegetation patterns and the characteristics of its dynamic environment [1, 2]. However, few have studied specifically the relationship between human impact and scarping with *A. breviligulata*.

Our research investigates the effects of human impacts and scarping on the characteristics of *A. breviligulata* on Lake Michigan foredunes.

Study Objectives

Our study objectives were:

1. To investigate the nature of human impact and scarping at our study sites.
2. To measure *A. breviligulata* characteristics on 3 foredune areas: area with scarps, area with human impact, and area without scarp and human impact.
3. To investigate if human impact and scarping influences the characteristics of *A. breviligulata* on a foredune.

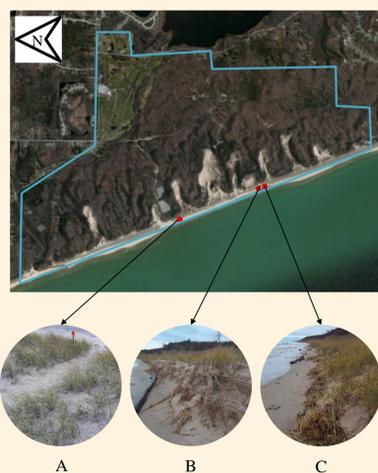
Study Areas

We studied 3 sites in Hoffmaster State Park that had distinct characteristics (Fig. 1):

- A foredune with no significant human impact and scarp (control)
- A foredune with significant human impact
- A foredune with a significant scarp

Our study areas measured 20m from north to south. Each study area extended from the edge of the windward slope to the edge of the leeward slope of the foredune.

Figure 1: Locations in Hoffmaster State Park and photos for three foredune study areas identified as A - Human Impact site, B - Scarp Site, and C - Control site.



Methods

From 23 Oct – 6 Nov 2014, we collected data using these methods:

1. Mapping study area, unmanaged trails and scarps using GPS.
2. Measuring height, health, and density of *A. breviligulata* sampled in quadrats placed at 15 randomly selected areas within each study site (Fig. 2).
3. Identifying characteristics of environment where *A. breviligulata* grows (Fig. 3).
4. Using observation and ranking to rate the overall health of *A. breviligulata*.
5. Measuring the height of the scarps at the foredunes.



Figure 2: Quadrat sampling



Figure 3: Identifying foredune features

Results

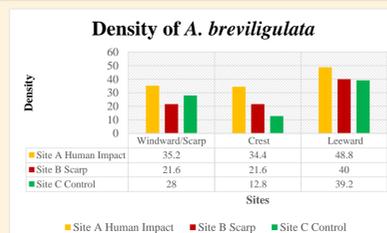


Figure 4: Density of *A. breviligulata*

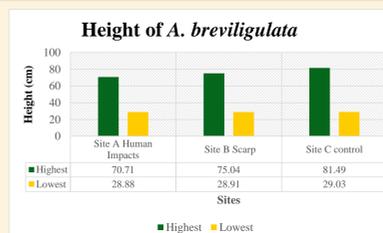


Figure 5: Height of *A. breviligulata*

On the windward slope, the density of *A. breviligulata* is greatest at site A, followed by site C and then site B. On the crest and the leeward slope, the density is greatest at site A, followed by Site B and then site C (Fig. 4). The average height of *A. breviligulata* is greatest at site C, followed by site B and then site A (Fig. 5).

Site	Average Overall Health (1 to 5)
A - Human Impact	3.7
B - Scarp	3.5
C - Control	3.9

Figure 6: Average overall health of *A. breviligulata*

On a scale of 1-5 (5 being the highest), the average overall health of *A. breviligulata* is greatest at site C, followed by site A and B (Fig. 6).



Figure 7: Mapped data from study areas. Note that base map is several years old and does not show current shoreline.

Besides the three trail segments mapped in site A, there was noticeable litter in each site. 2 out of 3 study areas had well-defined scarps, but the control area had a collapsed scarp composing the windward slope (Fig. 7). Site A had an average scarp height of 132.5 cm while Site B, 119.25 cm. At site C, there was no active scarp – the scarp had fallen and became the new windward slope. At a different site south of our study area, the scarp retreated an average distance of 2.21m during the second week of our study.

Discussion

Lower height and health in the area with human impacts support previous research showing that dune vegetation is sensitive to human impact [2]. The density of *A. breviligulata* does not support this view, suggesting that density might not be affected by human impact. However, we also think that this may be caused by two extreme values randomly sampled at sites B and C that skewed our data. Scarping directly impacts *A. breviligulata* by the edge of the scarp (Fig. 8), which may have skewed the data of the overall health rating. By comparing site B and site C (Fig. 9 and 10), the density of *A. breviligulata* suggest that the scarp might also influence the density of *A. breviligulata* on the foredunes. A previous study suggests that the topographic shape affects the airflow on the foredune and subsequently influences the growth of vegetation on the foredune [3]. Future research could look at the effects of scarps on the airflow on the foredune and the subsequent influence on the density of *A. breviligulata*.



Figure 8: Scarping's direct impact on *A. breviligulata*



Figure 9: Site B - Scarp



Figure 10: Site C - Control

Conclusions

Lower vegetation height and overall health at sites A and B suggest that human impact influences these characteristics of *A. breviligulata* on foredunes, while higher density suggests no such relationship. While scarping significantly impacts the vegetation health and growth by the edge of the scarp, there is not enough evidence to suggest that scarping influences vegetation across the entire foredune.

Acknowledgements & References

We would like to thank the Department of Geology, Geography and Environmental Studies, Calvin College and Michigan Space Grant Consortium for funding our research project. We also appreciate Hoffmaster State Park for allowing us to carry out our research at the park. We also are grateful for our mentor Natasha Strydhorst for her assistance as well as Professor Deanna van Dijk for her guidance.

1. Bitton, Michael C. A. and Patrick A. Hesp. 2013. "Vegetation Dynamics on Eroding to Accreting Beach-foredune Systems, Florida Panhandle." *Earth Surface Processes and Landforms* 38: 1472-1480
2. Ciccarelli, Daniela. 2014. "Mediterranean Coastal Sand Dune Vegetation: Influence of Natural and Anthropogenic Factors." *Environmental Management* 54:194-204.
3. Hesp, Patrick A., Ian J. Walker, Connie Chapman, Robin Davidson-Arnott, and Bernard O. Bauer. 2013. "Aeolian Dynamics Over a Coastal Foredune, Prince Edward Island, Canada." *Earth Surface Processes and Landforms* 38: 1566-1575.