Dune Advance and Vegetation on an Active Blowout
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Abstract
Few dunes have direct measurements of dune advance rates and directions. Our research explores whether it is possible to estimate dune advance through investigating patterns of vegetation. Our study focuses on an active blowout in the Kitchel-Lindquist-Harterg Dunes Preserve north of Grand Haven, Michigan. Sand movement, erosion, and deposition were measured with sand traps and emission pins over two weeks to determine sand transport rates and common directions of movement. In order to assess blowout activity, vegetation communities were mapped with handheld GPS units and species were recorded with random quadrat sampling. We mapped sand movement from Oct. 24 - Nov. 7, 2019. There was active sand transport over the dune crest towards the northeast, away from the outdoor learning center. The least sand movement was observed in stable dune areas with dense Ammophila brevigulata. Our results show that patterns of vegetation can be possible indicators of rates and directions of dune advance.

Methods
We measured dune activity and vegetation patterns on the blowout (Table 1, Figure 2). Field data was collected between Oct. 24 and Nov. 7, 2019. The blowout had very little sand transport during our study except for the week after snow and ice thaws [4].

From September through November no evidence of dune advance was recorded at the bottom of the leeward slope. Vegetation
Grasses were the most populous and dense community, taking up most of the northern and southern parts of the leeward slope (Table 2, Figure 5). Near the learning center areas of grass and trees were observed along with bare sand areas.

Results

Blowout Activity
The blowout had very little sand transport during our study except for sand trap 3 which recorded 39.1 kg/m²/week during the second week. Erosion pin 3 was the only pin that experienced significant deposition (Figure 3). Wind direction matched sand measured with sand traps and erosion pins (Figure 4).

Table 1. Objectives, methods, and equipment used

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Measurements</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure Dune Advance and Vegetation</td>
<td>Erosion pins (55 leverarms)</td>
<td>Leuconota armata (5 levearms)</td>
</tr>
<tr>
<td></td>
<td>Wind direction (5 wind vane)</td>
<td>Wind measurement site at Hoffmaster State Park</td>
</tr>
</tbody>
</table>

Table 2. Most common vegetation species.

<table>
<thead>
<tr>
<th>Community Type</th>
<th>Density plants/m²</th>
<th>Predominant Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasses</td>
<td>95</td>
<td>Atriplex brevigulata (American beach grass)</td>
</tr>
<tr>
<td>Shrubs</td>
<td>4</td>
<td>Calamagrostis longiseta (Prairie wheatgrass)</td>
</tr>
<tr>
<td>Trees</td>
<td>4</td>
<td>Populus alba (Giant willow)</td>
</tr>
</tbody>
</table>

Connections
Tree and shrub communities are areas of little sand movement during our study and these areas had the smallest plant densities. Grasses were the most widespread on the upper leeward slopes where there was more sand transport and deposition (Figure 5).

Discussion
The direction of wind and sand movement during our study does not support dune advance towards the learning center. Our data does match the strong west winds common during fall and winter on west Michigan dunes [3].

No evidence of sand reaching the bottom of the slipface during our study does not mean there is no dune advance. During fall and winter, wind-blown sand may accumulate on the upper slipface and not reach the bottom of the slipface until late spring after snow and ice thaws [4].

Bare sand areas on the upper leeward slope are likely from trampling rather than wind-blown sand movement (Figure 6).

Flourishing A. brevigulata on the upper leeward slope may indicate burial by sand from wind or trampling (Figure 7). Trees and shrubs indicate more stabilized parts of the leeward slope, which do not thrive on sand burial like grasses.

Conclusion
The blowout had active sand transport over the dune crest, but no sand reached the bottom of the slipface. Grasses on the upper leeward slope indicated deposition, and trees and shrubs were in more stabilized areas. Our results show that patterns of vegetation can be indicators of dune activity and advance.

Acknowledgements
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Works Cited

Figure 1. Study location on the east coast of Lake Michigan, with aerial and ground images of the blowout.

Figure 2. Measurement locations in the blowout.

Figure 3. Surface change measured at emission pins (+ = deposition; - = erosion).

Figure 4. Wind directions mapped over the study area.

Figure 5. Vegetation communities mapped against blowout characteristics.

Figure 6. Bare sand area on the leeward slope.

Figure 7. A. brevigulata on the leeward slope.