Previous dune research has shown that trails on dunes can influence blowout development, but there are no studies of the interactions between trails and blowouts on Lake Michigan dunes. In the fall of 2011, a study was undertaken to investigate relationships between trails and blowouts on a dune ridge in P.J. Hoffmaster State Park. We documented the characteristics of all trails and blowouts on a 1.2 km section of the dune ridge. Recorded blowout characteristics included height, length (parallel to shore) and width (perpendicular to shore); and for each trail, we recorded vegetation density, average width and orientation. We mapped the locations of each trail and blowout using GPS, and visually represented the data using GIS software. Results show spatial patterns of trails and blowouts within the study area. There are more trails than blowouts but most blowouts have trails running perpendicular to the shoreline. Such results suggest that blowouts are more likely to occur where trail orientation makes the dune surface vulnerable to erosion by southwesterly winds. Understanding the relationship between blowouts and trails can help identify potential areas where greater human impact can occur.

**Introduction**

Previous dune research has shown that trails on dunes can influence blowout development [1] but there are no studies of the interactions between trails and blowouts on Lake Michigan dunes. This study investigates trails and blowouts at Hoffmaster State Park, Michigan.

Our study objectives were to:
1. Document the characteristics of trails and blowouts.
2. Examine the relationships between trails and blowouts.

**Study Area**

This study focused on a portion of shoreline at P.J. Hoffmaster State Park in Michigan (Fig. 1). The park is a large, dynamic dune complex governed by a number of factors, including human activity, which shape dune systems in unique ways. The study area is a segment of the NE-oriented, stabilized dune ridge with blowouts present [2].

**Study Methods**

To document and compare the natural and human characteristics for blowouts, we created a Blowout Features Inventory (BFI), adapted from the Dune Features Inventory [3, 4]. The BFI is a systematic data collection procedure for documenting trail and blowout attributes such as width, length, height, orientation and vegetation density (Fig. 2).

**Results**

There are 31 blowouts in our 1.2 km dune-ridge segment. Blowouts had a range of sizes (Table 1). There were 22 blowouts that exhibited saucer shape qualities, and 9 were classified as trough blowouts (Fig. 5). Additionally, 97 percent of the blowouts were connected to at least one trail (Fig. 6).

<table>
<thead>
<tr>
<th>Type of Blowout</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Trough</td>
<td>26%</td>
</tr>
<tr>
<td>Saucer</td>
<td>71%</td>
</tr>
<tr>
<td>Mixed</td>
<td>3%</td>
</tr>
</tbody>
</table>

Blowout percentage in relation to trails

Trails within the study area included one Main trail and 32 Secondary trails. The Main trail is a managed trail parallel to shore along the crest of the dune ridge. The Secondary trails are mostly unmapped trails branching from the Main trail. They had average widths of 0.7 meters. Most trails had sparse and no vegetation present (Fig. 7). Approximately 75 percent of the trails had blowouts present. Average trail orientation was 79 degrees (east), compared to the shoreline orientation of 155 degrees (Fig. 8).

**Discussion**

The two clusters of blowouts are located in areas where foot traffic and other disturbances appeared to be intensified. Other research shows that high foot traffic can create unmapped trails [5], and those trails could aid in blowout development [1]. In Hoffmaster State Park we can see this pattern in Segment 4, where the greater number of blowouts seem to correspond with more traveled areas. The Main trail is a managed trail that is highly traveled, which may have led to a higher intensity of blowouts around the crest of the dune ridge. The vegetation density landward of the Main trail in Segment 2 may have concentrated foot traffic around the Main trail, leading to more Secondary trails and more blowout development.

**Conclusion**

We documented 31 blowouts and 33 trails in our 1.2 km stretch of dune ridge. Of the 33 trails, 31 were unmapped and 2 were managed. Spatial analysis shows a relationship between trails and blowouts. Two blowout clusters can be identified where increased trail activity is present. The high intensity of blowouts around the Main trail does suggest that these features are connected.

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**References**