Interactions Between Blowouts and Trails in a Lake Michigan Coastal System

Jared M. Stratz, Rian R. Bylsma, Sydney B. Carrick, Hannah M. Damsteegt, Timothy J. Nykamp, Calvin College

Abstract

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 in 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 through them. A high percentage of blowouts have trails with orientations 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 to identify potential areas where greater human impact can occur.

Introduction

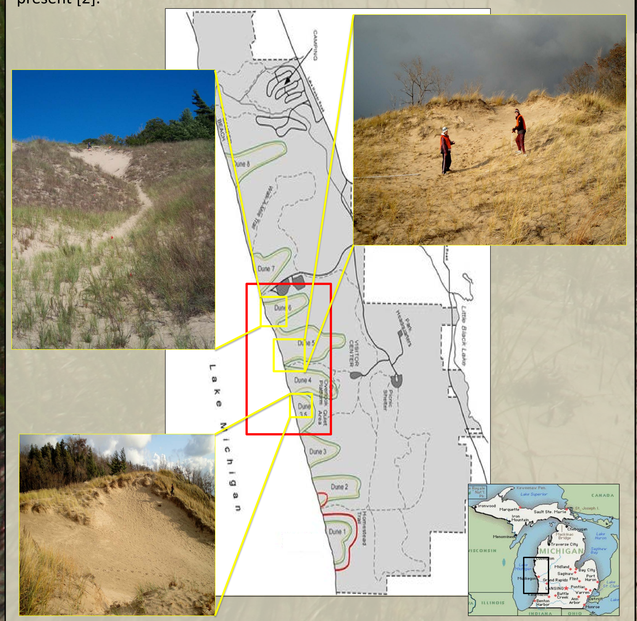
Previous dune research has shown that trails on dunes can influence blowout development [1] but there are no studies of the interactions between trails and blowouts on Lake Michigan dunes. This study investigates trails and blowouts at Hoffmaster State Park, Michigan.

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].



▲ Figure 1: Data was collected in a 1.2 km section of beach stretching from Dune 6 to Dune 3. Location of study area within the park with examples of specific blowouts and trails recorded. Insert shows location in Michigan.

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).

▼ Figure 2: Sections on the BFI checklist with example questions.

General Information	Dune location
	Feature Identifiers
	Field Data Collection
Human Impacts	Unmanaged Trails
	Trail Intensity
Management	Managed Trails
	Boardwalks
Natural Features	Ecology
	Geomorphology

E. Human Impacts: Unmanaged Trails

1. Are unmanaged trails present?
☐ No *(if no skip to next section)*
☐ Yes

2. Describe the intensity of the trail system
☐ Low – 1 or 2 trails on or leading to blowout
☐ Intermediate
☐ High – interconnected network of trails on blowout

3. Vegetation on trails *(check all that apply)*
☐ No vegetation on trail
☐ Sparse vegetation on trail
☐ Trail overgrown with bare portions visible
☐ Trail completely vegetated

F. Management: Managed Trails

1. Are managed trails *(excluding boardwalks)* present?
☐ No *(if no skip to next section)*
☐ Yes

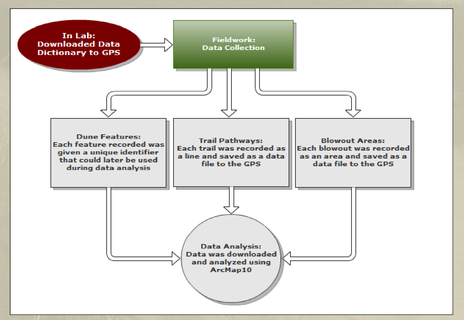
G. Management: Boardwalks

1. Is a boardwalk present?
☐ No
☐ Yes

C. Natural Features: Geomorphology

1. Site has:
☐ Blowout ☐ Trail ☐ Both
2. Number of blowouts at site: _____
3. Type of blowout:
☐ Trough ☐ Saucer
4. Number of trails at site: _____
5. Orientation of trails: _____ *(if sinuous, take multiple measurements)*
6. Average width of trail (m): _____
7. Height of blowout (m): _____ *(Measure from lowest point to highest)*
8. Width of blowout (m): _____ *(Measurement perpendicular to shoreline)*
9. Length of blowout (m): _____ *(Measurement parallel to shoreline)*
10. GPS data collected for:
☐ Blowout (polygon)
☐ Trail(s) (line)

We used Juno Trimble GPS units to map the spatial patterns of blowouts and trails in our study area. The units enabled us to collect field data on dune features, trail pathways and blowout areas (Fig.3, 4).



◀ Figure 3: Flowchart explaining the process of data collection using the GPS units.

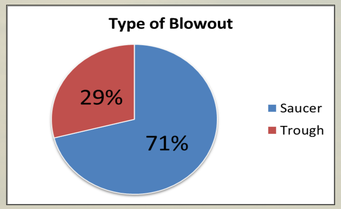
▲ Figure 4: Research team collecting spatial data.

Results

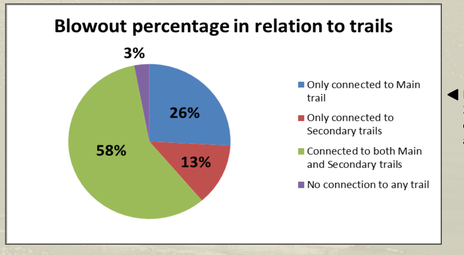
There are 31 blowouts in our 1.2 km dune-ridge segment. Blowouts had a range of sizes (Table 1). There were 22 blowouts that exhibited saucer-shape qualities, and 9 were classified as trough blowouts (Fig. 5). Additionally, 97 percent of the blowouts were connected to at least one trail (Fig. 6).

Table 1: Blowout Characteristics

	Minimum	Maximum	Average
Height (m)	0.1	10.6	3.11
Length (m)	0.65	90	15.056
Width (m)	1.6	92.7	15.132



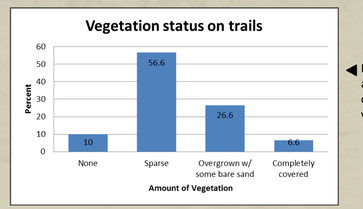
◀ Figure 5: Almost three-quarters of the blowouts identified were saucer-shaped.



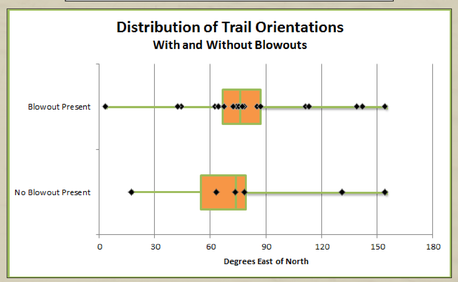
◀ Figure 6: Over half of the 31 blowouts were connected to both Main and Secondary trails.

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 unmanaged 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).



◀ Figure 7: Trails were classified as either completely vegetated, overgrown, sparse or no vegetation present.



◀ Figure 8: This graph depicts a boxplot of trail orientations separated between trails with and without blowouts. The data points show the orientations of the trails.

Results

Mapped GPS data shows a distinct distribution of blowouts and trails (Fig. 9). There are two larger clusters of blowouts. The southern-most cluster (Segment 4) is located at the mouth of a managed trail between the park visitor center and the beach. The northern-most cluster (Segment 2)is located in an area where there are thicker vegetation densities landward of the dune ridge. These two clusters contain the majority of the larger blowouts recorded at the site. Segment 2 has 7 trails and 8 blowouts and Segment 4 has 6 trails and 6 blowouts.

Secondary trails and blowouts tend to occur at the same locations. Approximately 84 percent of the blowouts were on the Main trail or connected to the Main trail and Secondary trails (See Fig. 6).

◀ Figure 9: Map showing distribution of trails and blowouts. Study area was split into four segments that exhibit different characteristics.

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 unmanaged 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 along 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.

Conclusions

We documented 31 blowouts and 33 trails in our 1.2 km stretch of dune ridge. Of the 33 trails, 31 were unmanaged 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.

Acknowledgements

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Bibliography

[1] Bate, Guy, Ferguson, Michele. 1996. Blowouts in coastal foredunes. Landscape and Urban Planning 34; 215-224

[2] van Dijk, Deanna. (2004). "Contemporary Geomorphic Processes and Change of Lake Michi8gan Coastal Dunes: An Example from Hoffmaster State Park, Michigan." Michigan Academician 35: 425-453.

[3] Beauchamp, J., F. Van Baak and D. van Dijk. 2009. "Creating a Dune Features Inventory (DFI) for Michigan coastal dunes." Annual meeting of the Association of American Geographers (Las Vegas, NV), 22-27 March 2009; poster.

[4] Ferwerda, B. and D. van Dijk. 2010. "Determining human impacts and management presence in Lake Michigan coastal dunes." Annual meeting of the Association of American Geographers (Washington, DC), 14-18 April 2010; poster.

[5] Bowles, J. M., and M. A. Maun. 1982. "A study of the effects of trampling on the vegetation of Lake Huron sand dunes at Pinery Provincial Park." *Biological Conservation* no. 24:273-283.