Contemporary Geomorphology of Great Lakes Dunes

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Introduction

Research Objective: To study how contemporary processes are changing Lake Michigan coastal dunes.
Study Location

Lake Michigan

Wisconsin

Michigan

Ontario

Lake Huron

Lake Erie

Indiana

Indiana Dunes

Sleeping Bear Dunes

Manistee

Ludington

Muskagon

P.J. Hoffmaster State Park

Grand Haven

Holland

85°W

100 km

-44°N
Study Location Geomorphology

- Fatherdune
- Dune ridge
- Parabolic dune
- Beach

Distance (m) from shore of Lake Michigan

Height (m) above lake
Study Location Geomorphology

- Foredune
- Dune ridge
- Parabolic dune
- Beach

Distance (m) from shore of Lake Michigan

Height (m) above lake

-50  50  150  250  350  450  550
Study Location Geomorphology

- Height (m) above lake
- Distance (m) from shore of Lake Michigan

- Foredune
- Dune ridge
- Parabolic dune
- Beach
Study Methods

Hoffmaster State Park Study Area
12 April 2003

- Survey Point
- Erosion Pin
- Sand Trap (Leatherman)
- Sand Trap (Winter)
- Benchmark
- Instrument Tower
- Shed and Solar Panel
- Soil Temperature Probes

Elevations are meters above sea level.
Lake Michigan level in April 2003 was 175.81 m.
Contour interval is 1 meter.

Scale bar along map borders are in meters.
N.B. Contour lines become less accurate near edges of map because there are less points for interpolation.
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Results: Dune Changes

[Graph showing changes in dune elevation over time with various data points marked for different months from Dec 2000 to Apr 2006.]
Results: Dune Changes

[Graph showing dune changes over time with various markers for different dates: Dec 2000, Apr 2001, Apr 2002, Apr 2003, Apr 2004, Jun 2005, Apr 2006. The graph plots distance (m) on the x-axis and elevation (m a.s.l.) on the y-axis.]
Results: Annual Rates of Change

<table>
<thead>
<tr>
<th>Year</th>
<th>Change in m³ m⁻¹ width</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-01</td>
<td>4.3</td>
</tr>
<tr>
<td>2001-02</td>
<td>4.8</td>
</tr>
<tr>
<td>2002-03</td>
<td>1.9</td>
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<tr>
<td>2003-04</td>
<td>2.8</td>
</tr>
<tr>
<td>2004-05</td>
<td>2.3</td>
</tr>
<tr>
<td>2005-06</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Results: Seasonal Patterns

Summer
- weak winds
- dry sediments
- maximum vegetation growth
- estimated 0-10% annual dune change

1961-1990 wind data for Muskegon, MI, from National Weather Service
Results: Seasonal Patterns

Autumn
- strong winds
- wet surface conditions
- variable beach width
- estimated 30-75% annual dune change

1961-1990 wind data for Muskegon, MI, from National Weather Service
Results: Seasonal Patterns

Winter
- strong winds
- variable surface conditions (snow, ice, frozen)
- niveo-aeolian transport
- estimated 25-50% annual dune change

1961-1990 wind data for Muskegon, MI, from National Weather Service
Results: Seasonal Patterns

Spring
- variable winds
- moist surface conditions (thawing snow ice, and niveo-aeolian deposits)
- estimated 15-35% annual dune change

1961-1990 wind data for Muskegon, MI, from National Weather Service
Conclusions... and applications

- Lake Michigan coastal dunes are complex and fascinating environments.
- We still have a lot to learn.
Conclusions...and applications

- Contemporary change is site specific...

PJ Hoffmaster State Park in January 2005
Conclusions...and applications

- Contemporary change is site specific...
- ...but some knowledge is transferable.

North Beach Park parabolic dune in January 2005
Conclusions...and applications

- Effective management needs a solid understanding of site characteristics and contemporary processes.

Mt. Pisgah (Holland, MI) in July 2005
Acknowledgements

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