Variables affecting *Cirsium pitcheri* at Rosy Mound Natural Area, Michigan
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**Abstract**
Endemic to the Great Lakes dunes, *Cirsium pitcheri* is threatened at the state and federal level because of both natural and anthropogenic variables. This study examines these variables affecting *C. pitcheri* at Rosy Mound Natural Area on Lake Michigan’s eastern shore. In fall 2014, we analyzed *C. pitcheri* in three open dune study areas, collecting species and bare sand composition, and slope in each. Site A, with 2.7% slope, was closest to the shore and adjacent to a boardwalk. Site B, with 10.0% slope, was on a windward slope adjacent to an unmanaged trail. Site C, with 25.3% slope, was on a leeward slope with a trail-free buffer. For each plant, leaf length and GPS location was recorded. For a random selection of individuals, a point-quarter vegetation survey was used to identify the nearest species neighbor. Results show similar spatial distribution of *C. pitcheri* is directly affected by topography and indirectly affected by anthropogenic effects.

**Introduction**
The Great Lakes coastal dune ecosystems are diverse and unique, but decreasing due to development. Subsequently, endemic dune plants, including *Cirsium pitcheri* (federally threatened), are disappearing. *C. pitcheri* (figure 1) is threatened by a variety of natural and anthropogenic environmental variables [1,2]. Our study investigated the different characteristics and variables affecting *C. pitcheri* at a Lake Michigan dune site.

**Our study objectives** were to:
- Measure *C. pitcheri* characteristics and environmental variables at 3 study sites with different characteristics;
- Analyze and compare patterns within and between each study site.

**Study Area**
Our 3 study sites are located on the southeast shore of Lake Michigan at Ottawa County Parks (figure 2). Rosy Mound Natural Area is a coastal park with an established boardwalk system through a variety of dune ecosystems.

**Methods**
In Autumn 2014, we identified three 16m×16m study sites, containing populations of *C. pitcheri*, based on proximity to a trail or boardwalk, topography, and the surrounding environment (table 1).

<table>
<thead>
<tr>
<th>Site Characteristics:</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>adjacent to boardwalk</td>
<td>minimal slope</td>
<td>no trees bordering site</td>
</tr>
<tr>
<td>Dune Type</td>
<td>adjacent to unmanaged trail</td>
<td>medium slope</td>
<td>trees on 2.5 sides</td>
</tr>
<tr>
<td>Human Impact</td>
<td>no adjacent trail</td>
<td>high slope</td>
<td>trees on one side</td>
</tr>
</tbody>
</table>

**Results**
A total of 82 *C. pitcheri* plants was recorded. Sites B and C had similar numbers at 36 and 35 respectively and site A had fewer with 11 plants. 80% of the plants surveyed had no overhead vegetation in two, three or all four quarters in the point quarter survey (figure 3). The most common nearest plant in all three sites was *Calamavilfa longifolia*. Site C included *Leymus arenarius*, an invasive species. Spatial patterns of *C. pitcheri* (figure 4) and site characteristics (table 2) differed between the three study sites.

**Discussion**
The *C. pitcheri* population at Rosy Mound seems to be healthy due to the variety of locations and size classes present. According to our point quarter survey results, vegetation density surrounding individual *C. pitcheri* plants must be moderately vegetated. Site A had the fewest *C. pitcheri* plants and had the least evidence of human presence while site B and C had the most evidence of human impact and more *C. pitcheri* plants. This suggests that human presence and number of *C. pitcheri* is not directly connected. At site B and C, topography was steep in areas without *C. pitcheri* suggesting that there is a maximum angle at which *C. pitcheri* thrives.

**Conclusion**
The *C. pitcheri* population at Rosy Mound is diverse in age and location. While anthropogenic impacts have a large scale effect on the species of *C. pitcheri*, direct human impact does not seem to have the most significant impact. Topography and vegetation density seem to have the highest impact on where and how *C. pitcheri* grows [3].

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**Works Cited**