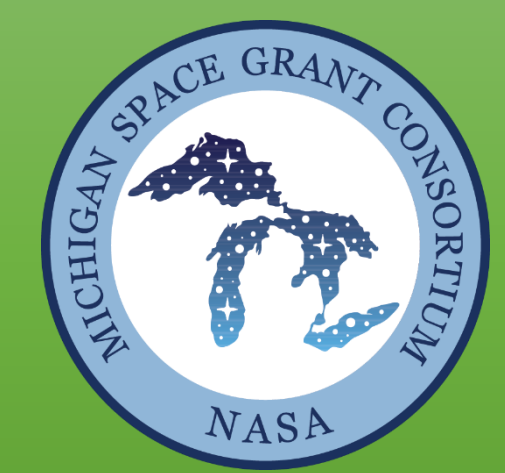


The Effects of Sand Fences on Threatened and Generalist Species on Lake Michigan Coastal Dunes

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Abstract

The survival rate of the threatened plant Pitcher's Thistle (*Cirsium pitcheri*), which is endemic to the Lake Michigan coast, depends on various specific factors within a dune. This study investigates how sand fences affect *C. pitcheri* populations and other general vegetation on a Lake Michigan coastal dune system. *C. pitcheri* individuals within North Beach Dune were located and marked with GPS Trimble Juno systems. General vegetation information was also taken at the Kirk Park, North Beach Park, and Mt. Pisgah dune systems. Quadrats were placed on transects downwind of certain fences within the parks for the vegetation data. The results found that thistles, as well as most other vegetation, were found primarily downwind of sand fences. The lack of thistles in two of the parks is particularly intriguing. Although presence of spotted knapweed could have inhibited thistles from growing, further analysis of these parks is needed to determine why *C. pitcheri* is not successfully growing in ideal environments, specifically behind the shelter of functioning sand fences.

Introduction

Sand fences have been shown in prior studies [1] to increase vegetation density in the areas surrounding them on coastal dunes. Other studies [2] provide specific parameters under which *C. pitcheri* (fig. 1) thrives, including certain amounts of disturbance and burial. The relationship between these has not been investigated yet. Our study researched how sand fences affect the presence and spatial patterns of *C. pitcheri* and general vegetation. The study was influenced by results from Dong *et al.* [3] and used methods that were similar to those in D'Ulisse and Maun [2].

Objectives

The objectives of this study were to:

- Investigate vegetation patterns relative to sand fences
- Record the presence and spatial patterns of *C. pitcheri* in the study areas
- Consider variables affecting the presence of *C. pitcheri* around sand fences



Figure 1: *Cirsium pitcheri* [5] is a flowering thistle species native to the Great Lakes coastal area.

Study Locations

The study was conducted at three sites on the coast of Lake Michigan (fig. 2). The Kirk Park study site was on a small foredune which had been scaped by the lake to about 7 meters. The Mt. Pisgah and North Beach Dune study sites are both large parabolic dunes that have similar physical shapes.

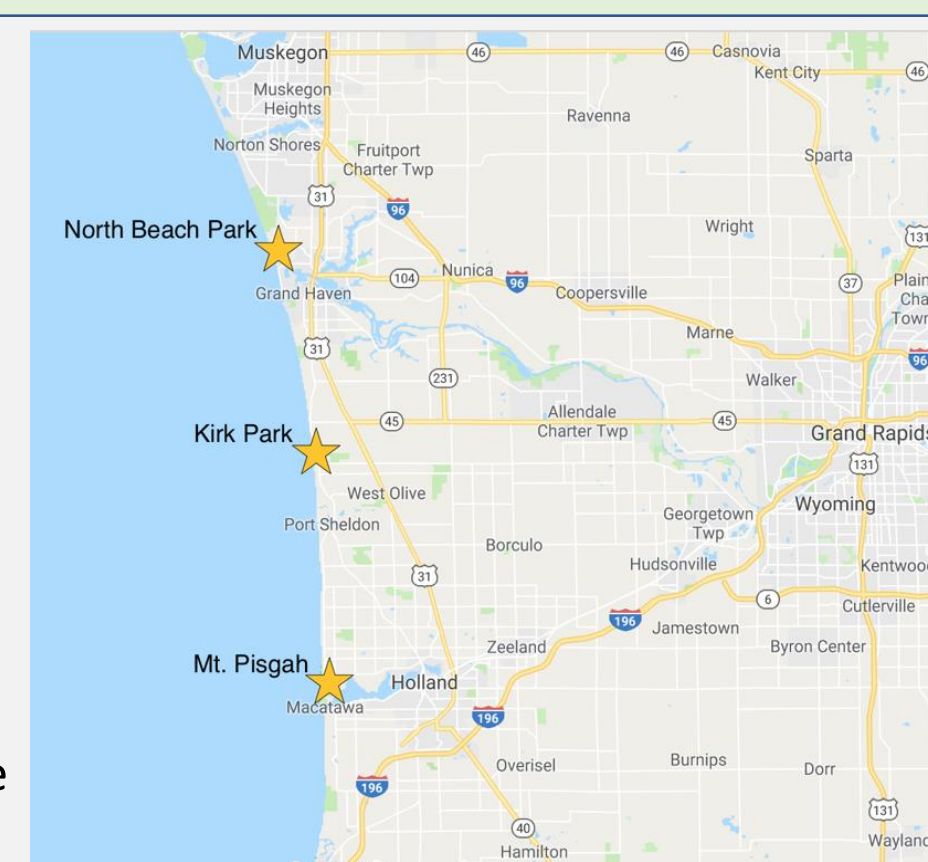


Figure 2: Locations of the three research sites.

Methods

Study Objective	Data Collected	Methods
Investigate vegetation patterns relative to sand fences	<ul style="list-style-type: none">• Vegetation characteristics: species, density, height• Sand fence locations	<ul style="list-style-type: none">• Sampling along transects with vegetation data collected in quadrats• Mapped with GPS
Record the presence and spatial patterns of <i>C. pitcheri</i> in the study sites	<ul style="list-style-type: none">• Locations of <i>C. pitcheri</i> on the dunes	<ul style="list-style-type: none">• Mapped with GPS
Analyze the results for relationships between sand fences and <i>C. pitcheri</i>	<ul style="list-style-type: none">• Locations of sand fences and <i>C. pitcheri</i>	<ul style="list-style-type: none">• Mapped with GPS

Table 1: Data collected for each specific study objective and the methods used to collect the data.

The distance of transects from the fence was chosen based on results from a study on sand fence porosity [3].

Results

There was a high vegetation density around sand fences at all sites (Table 2), particularly on the leeward sides of the fences.

Study Location	Average Plant Densities (# plants/meter squared)	Avg. Plant Height (cm)	Spotted Knapweed Presence	Thistle?
Kirk Park	45	44	Yes; isolated	No
Mt. Pisgah	20	54	Yes; dense	No
North Beach Dune	26	36	Yes; isolated	Yes

Table 2: Vegetation data from each study site.

The study found that there were no *C. pitcheri* present near sand fences or otherwise at Kirk Park or Mt. Pisgah. They were present at North Beach Dune (fig. 3). Mt. Pisgah does not have large active areas like those in North Beach Dune. In addition, Mt. Pisgah has many spotted knapweed throughout the dune.

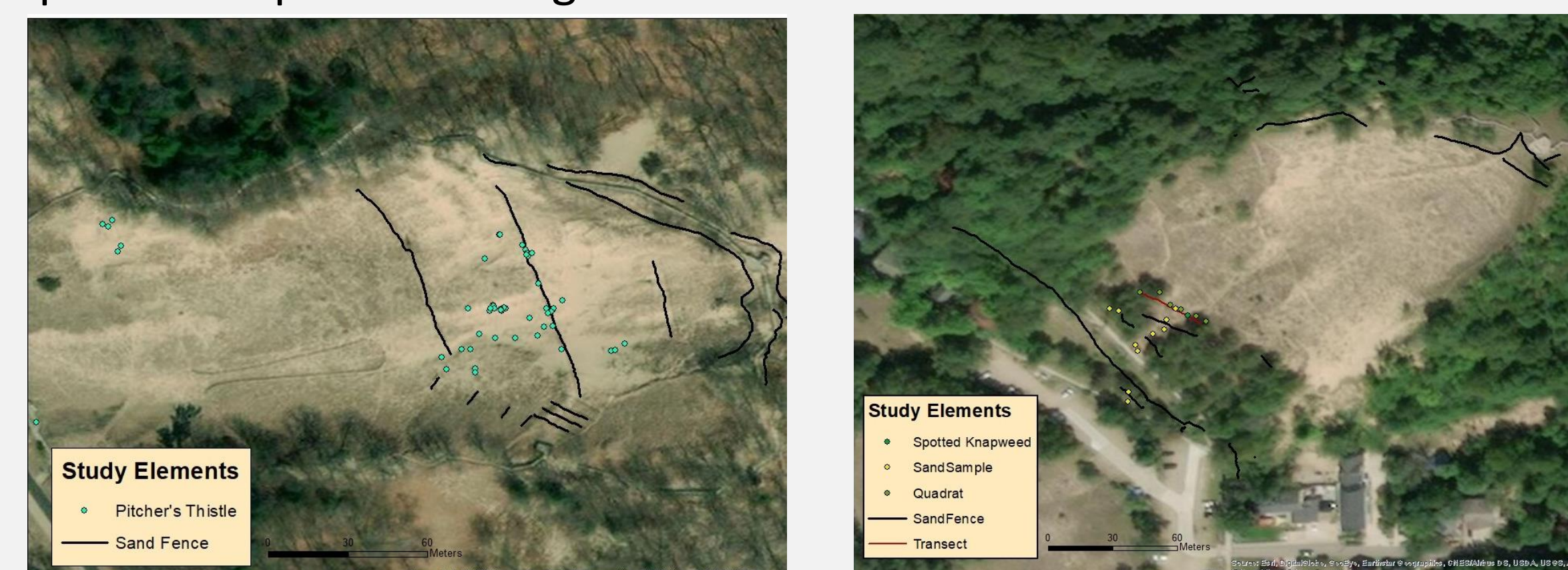


Figure 3: *C. Pitcheri*, sand fence, and sand sample locations mapped on aerial views of the North Beach study site (left), and Mt. Pisgah study site (right).

A large amount of *C. pitcheri* found at North Beach Dune was near two sand fences, with a slight preference for the leeward side of both. There was no spotted knapweed within the areas that *C. pitcheri* was present.

Discussion

Results from the Mt. Pisgah and North Beach Park sites show a high diversity and density of plants along the transects 3m upwind and downwind of the sand fences, similar to the results found in previous studies [1].

C. pitcheri was only present at North Beach Park. The majority of *C. pitcheri* found at North Beach Park was located near one of the sand fences on the dune, suggesting that the sand fences could affect *C. pitcheri* in some way.

Mt. Pisgah is a more densely vegetated environment and is more stable, which makes for less ideal burial and sun conditions described for *C. pitcheri* [4]. However, the similarities between North Beach Park and Mt. Pisgah indicates that there are more factors influencing the survival of *C. pitcheri*, such as the abundance of spotted knapweed at Mt. Pisgah.

Conclusions

The findings at North Beach Dune indicate a potential connection between sand fences and *C. pitcheri* populations, but no *C. pitcheri* was found at the physically similar Mt. Pisgah dune. This could have been due to the presence of spotted knapweed (fig. 4) at the Mt. Pisgah location inhibiting *C. pitcheri*, but that is only one possibility. Therefore, we recommend future investigation into the relationship between *C. pitcheri* and sand fences.



Figure 4: Spotted knapweed [6] is an invasive species to Lake Michigan coastal dunes.

Acknowledgements

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Works Cited

- [1] Grafals-Soto, Rosana. 2011. "Effects of sand fences on coastal dune vegetation distribution." *Geomorphology* 145-146: 45-55.
- [2] D'Ulisse, Angelo. and M. A. Maun. 1996. "Population ecology of *Cirsium pitcheri* on Lake Huron sand dunes: II. Survivorship of plants." *Canadian Journal of Botany* 74(11): 1701-1707.
- [3] Dong, Zhibao, Guangqiang Qian, Wanyin Luo, and Hongtao Wang. 2006. "Threshold velocity for wind erosion: the effects of porous fences." *Environmental Geology* 51: 471-475.
- [4] Rowland, Jennifer, and M. A. Maun. 2001. "Restoration ecology of an endangered plant species: Establishment of new populations of *Cirsium pitcheri*." *Restoration Ecology* 9 (1): 60-70.

Image sources :

- [5] Morse, Keir. 2016. "*Cirsium pitcheri*; Pitcher's Thistle." CalPhotos. (pitcher's thistle image)
- [6] Teton County Weed & Pest District (spotted knapweed image)