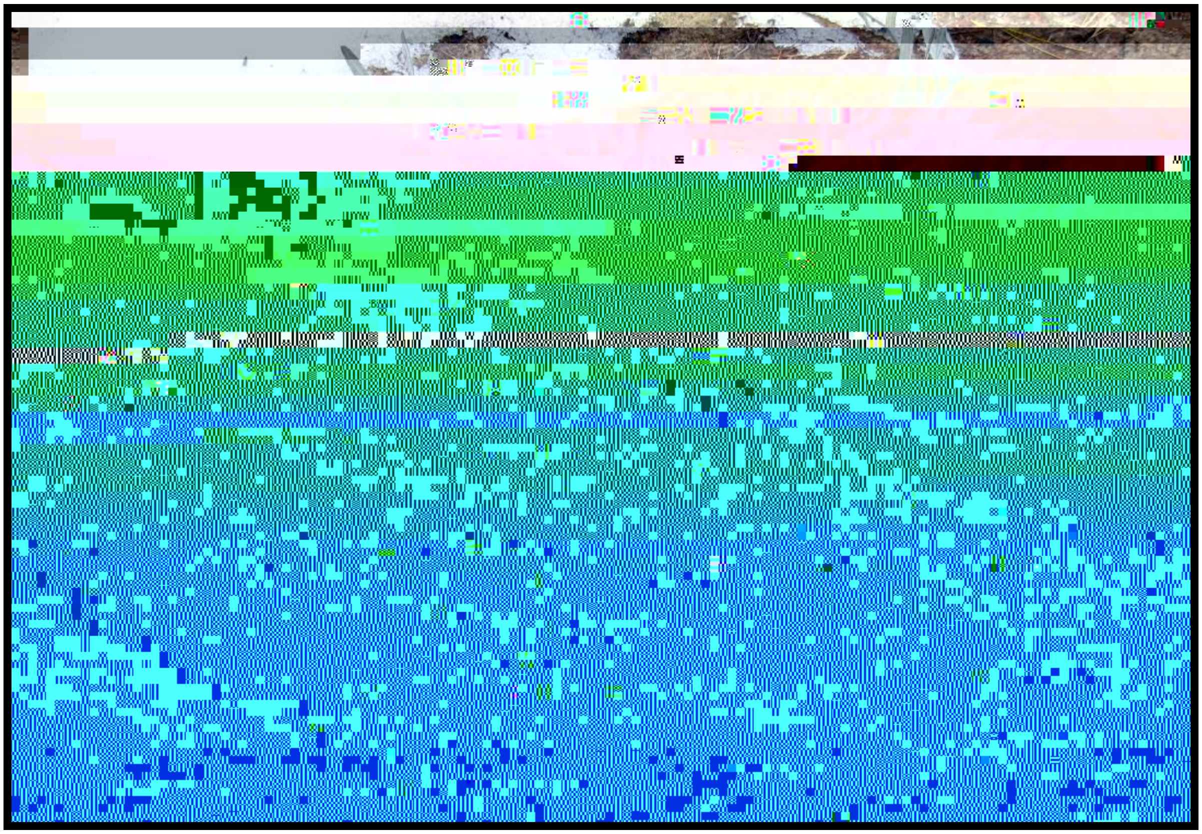
First-



Dune Environment Influences on a Rare Great Lakes Thistle:
An Investigation in Ottawa County Parks' Rosy Mound Natural Area

by Natasha Strydhorst, Carolina Angulo, Anna Camilleri,
Ethan DeVries, and Anna Selles

FYRES: Dunes Research Report #9
May 2014

Department of Geology, Geography and Environmental Studies
Calvin College
Grand Rapids, Michigan

1.0 Abstract

Native to the Great Lakes dunes, *Cirsium pitcheri* is listed as threatened at both the state and federal level and is sensitive to changing environments. This study investigated the *C. pitcheri* population and its environmental conditions in Rosy Mound Natural Area on Lake 0LFKLJDQ¶V HDVWHUQ VKRUH 'XULQJ WKH IDOO RI ZH unmanaged trails (both deer and human-FDXVHG DQG WKH SDUN¶V June ERDUGZDO GPS units. For each plant, we recorded surface conditions, longest leaf length, and whether deer trampling and/or grazing was evident. We also compared four plant population areas characterized by different features: the managed boardwalk, an unmanaged human trail, an unmanaged deer trail, and an open dune area. Significant evidence of deer was visible around the 253 individual plants mapped. Despite the deer presence, few indications of damage to *C. pitcheri* from trampling or grazing were observed. 7KH WKLVWOHV¶ GHQVLW\ ZDV VL boardwalk and human-caused unmanaged trail, and greater around the deer trail and open dune areas. Our results suggest that the deer population is ideally sized to provide the disturbance required by *C. pitcheri* without exerting undue strain on the population.

2.0 Introduction

/DNH 0LFKLJDQ¶V VD distinctive shapes to wind patterns [(sha)3(pe)] TwI c] T72e1

Ceaterm[(2sha)3(pe)] T1 3.19 3DC 2.2 .024 43(3)5(e) 4(n)4 introduction

3.0 Background

3.1 Cirsium pitcheri

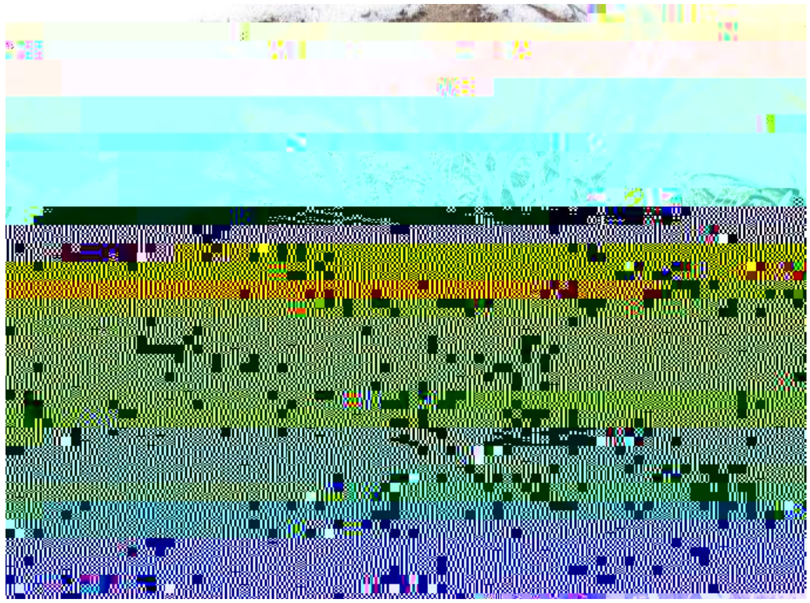


Figure 1: C. pitcheri rosette.

C. pitcheri is a monocarpic perennial (Phillips and Maun 1996; Chen and Maun 1998; Girdler and Radtke 2006), recognizable by furry, pale blue-green leaves protruding in a rosette from W K H S O center (figure 1). The thistles are typically under 1 meter tall and supported by an exceptionally long taproot, an adaptation well-suited to a dry, sandy environment such as the Lake Michigan dunes (Hamzé and Jolls 2000; Voss and Reznicek 2012, 384). C. pitcheri lives between four and eight years before flowering once (figure 2) and expiring (Loveless 1984; Havens et al. 2012). The thistle falls under Yorks et al. ¶ (1997) classification as a perennial forb growth form endemic to the dunes zone of the temperate climate belt. C. pitcheri thrives in the environmental conditions unique to this region. These conditions include the presence of bare

Figure 2: C. pitcheri in bloom (flowers highlighted)

3.2 The influence of trampling, grazing, and unmanaged trails on *Cirsium pitcheri*

Though *C. pitcheri* is adapted to a dynamic habitat, it is not adapted to one substantially altered by non-aeolian (and especially anthropological) activities (Carlson and Godfrey 1989). Trampling has been shown to disturb vegetative growth and decrease biodiversity in plant communities in a broad range of biomes. In particular, those locations in which the substrate is most liable to be deformed are considered the most noticeably vulnerable to the damaging effects of trampling (Yorks et al. 1997). *C. pitcheri* is also sensitive to R Y H U J U D] L Q J ' ¶ 8 O L V V H D 1996) and large-scale human disturbances such as recreation and construction (Carlson and Godfrey 1989; Havens et al. 2012).

Although trampling as a result of any traffic (be it human, animal, or machinery) is generally deemed destructive, a moderate grazing presence may be considered benign or even beneficial. Small-scale observations by Kohyani et al. (2008) suggest that the adverse loss of plant biomass to animal browsing can be overcome by the benefits of moderate grazing: decreased competitive pressure and increased biodiversity. A particular proportion of predator (grazer) to prey (*C. pitcheri*) is suggested to paradoxically benefit both species.

Human influences on *C. pitcheri* and its habitat in the Great Lakes dunes frequently occur in the shape of unmanaged trails. These bare or sparsely vegetated areas are formed by habitual trampling of the foliage resulting in a O R V V R I E L R P D V V L Q D G L V W L Q F W S D W areas. Human-caused unmanaged trails are the culmination of many trampling influences concentrated in a deliberate path, frequently leading to or from the beach area (Bowles and Maun 1982). Deer establish unmanaged trails in addition to isolated trampling and grazing effects. These trails reduce vegetation cover to a lesser extent than human or ORV (off-road vehicle) trails do (Carlson and Godfrey 1989) as they tend to be narrower.

Yorks et al. (1997) found that traffic in sensitive environments decreases the total number of species present when trampling is a regular occurrence. This gives a competitive advantage to those species with high resistance and/or resilience classifications. The growth forms with the highest resistance to trampling are trees, graminoids, and cryptophytes, while the highest resilience² the ability to recover quickly from the effects of a disturbance² is exhibited by graminoids, cryptophytes and forbs.

4.0 Study area

7KLV VWXG\ ZDV FRQGXFWHG LQ 2WWDZD &RXQW\ 3DUN (figure 4). The 164-acre dune preserve is located on the eastern shores of Lake Michigan, south of Grand Haven (Ottawa County Parks 2014b). The park exhibits diverse dune topography, containing hummocky foredunes, wooded dunes, a dune blowout and beach. A managed boardwalk winds 2.17 km (1.35 mi) through the study area (figure 4), which is connected to the parking lot by an additional 1.13 km (0.7 mi) of trail. Private residential zones border Rosy Mound Natural Area to the north, east, and south, while Lake Michigan marks its western edge.

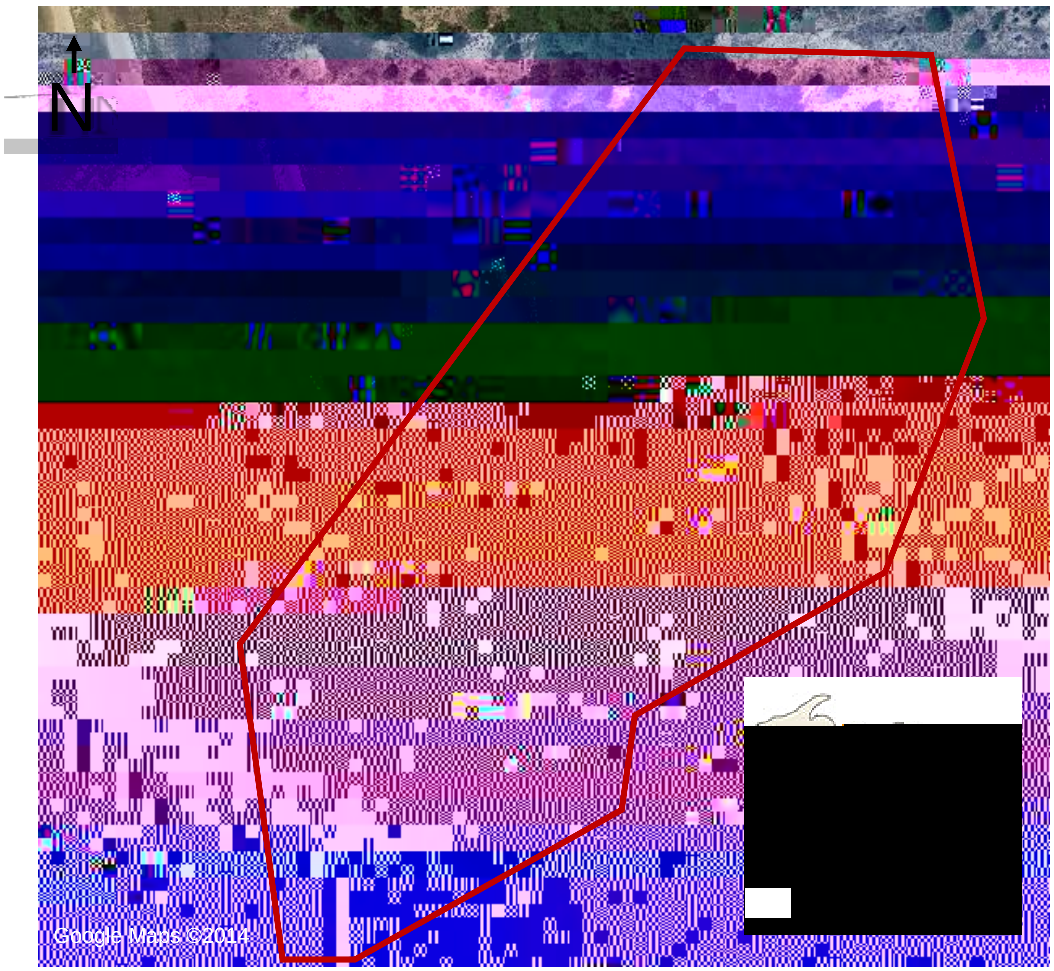


Figure 4: Aerial photograph of study site (outlined in red) on Lake Michigan, Ottawa County., QVHW PDS VKRZV 2WWDZD &RXQW\¶V (Ottawa County Parks 2014a).

5.0 Methods

Our primary method of data collection was mapping. Using Trimble Juno GPS units, we recorded the locations of individual *C. pitcheri*, informational signs, viewing platforms, and the eight erosion pins we positioned around the site. The GPS units were also used to record the locations and length of the boardwalk and a selection of the numerous unmanaged trails.

GPS data were downloaded and post-processed, then imported into ArcGIS to be arranged and displayed for spatial analysis. Four areas of *C. pitcheri* populations were identified for analysis, defined by proximity to the boardwalk, unmanaged (human) trail, unmanaged (deer) trail, and open dune area (figure 5). A surface sediment sample was collected from the foredune and grain-size analysis performed to measure the sand characteristics in Rosy Mound Natural Area.

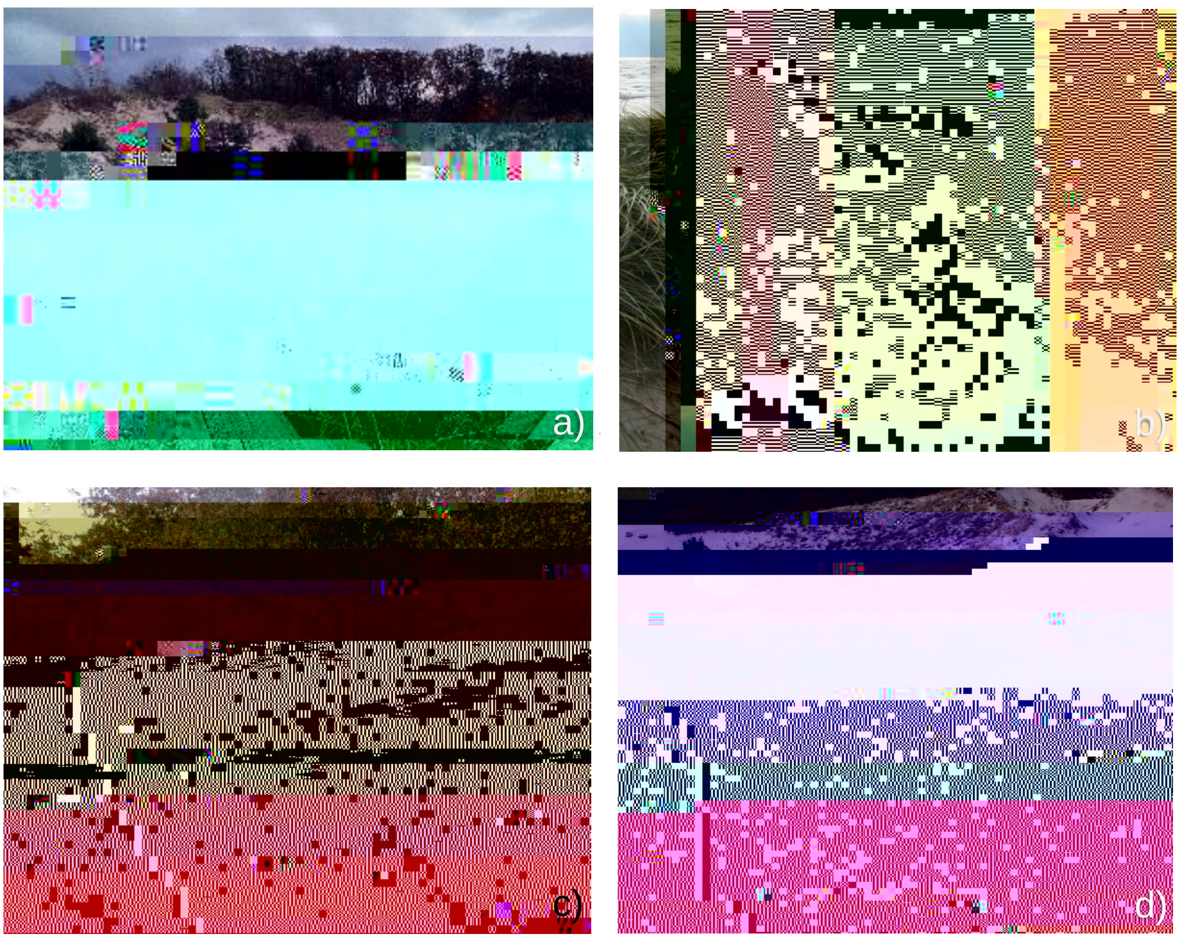


Figure 5: ([DPSOHV RI D WKH SDUN¶V PD-caused unmanaged trail,
1.04 n (4 0 g e(0fDtsn60056>-osBr 016s5haic00C>-5<0003>11n6s5haic00C>-5>-5n)1:

We studied *C. pitcheri* for evidence of trampling and grazing, as well as presence or absence of other vegetation in their near vicinities. These were recorded in the GPS units using pull-down menus to categorize characteristics such as damage to plants, surface conditions in the W K L V W O H V ¶ Y L F L Q L W L H V (Table 1) D Q G O R Q J H V W O H D I O H Q J W K V

A partial sample, consisting of 36% of the thistles analyzed, was assessed to determine the immediate surroundings of the thistles in the hummocky dunes and dune ridge (excluding the blowout and trail network in the northern section of the study site).

Through field observations, we made note of each t K L V W O H ¶ V O R Q J H V W O H D I length (recorded based on * L U G O H U D Q G (2006) described method), likely causes of unmanaged trails, and erosion pin data collected during the final two site visits. Leaf lengths were not recorded for plants that had flowered and died. For living thistles, V L] H F O D V V H V Z H U H F R P S D U H G W R / R (1984) findings of stage-specific mortality to estimate the likelihood of the studied thistles surviving the year (Appendix A). Erosion pins were set at eight locations in the study site during the first week of observation, and measured each subsequent week to determine whether ² and where ² deposition and erosion had occurred. At398.59 Tm [(Thr)4tc(re)6()4(h subs ET e)4(ng)eat-4(e)410(ht r

6.0 Results

6.1 Weather and environmental conditions

Data were collected at Rosy Mound Natural Area over three consecutive weeks from late October to early November, 2013. Winds in the range of 2.0-5.7 m/s blew in from the northwest or southwest during observation sessions, with temperatures ranging from 5.0-15.8°C. Cloud cover was significant throughout all three site visits, producing a substantial amount of rain during the second. The weather data from Muskegon Airport (averaged over each week of th study) served as a baseline for the specific site data from each day of field work (table 2).

WEEK 1:	Region Data (October 20-26)	Site Data (October 24)
Temperature (°C):	7.0	8.4
Precipitation (mm):	13.20	Not Collected
Average Wind Speed (m/s):	5.0	2.0
Wind Direction:	Predominantly WNW	NW (310°)
WEEK 2:	October 27-November 2	October 31
Temperature (°C):	9.0	15.8
Precipitation (mm):	37.34	Not Collected
Average Wind Speed (m/s):	3.89	2.1
Wind Direction:	Variable	SW (222°)
WEEK 3:	November 3-9	November 7
Temperature (°C):	8.0	5.0
Precipitation (mm):	19.30	Not Collected
Average Wind Speed (m/s):	5.56	5.7
Wind Direction:	Variable	WNW (293°)

Table 2: Region weather data were collected at Muskegon County Airport (Wea
Underground 2014), approximately 18 km (11 mi) north of Rosy Mound Natural
Area. Site weather data were collected at the beginning of each site visit, while

Rosy Mound Natural Area's sand is very well sorted and nearly symmetrical, with a mean grain size of 0.29mm (Appendix B). While open sand areas (particularly in the blowout vicinity), and wooded areas are present, sparse to moderately dense grasslands comprise the prevalent vegetation community in the study site.

Two erosion pins had fallen out or been removed by the second site visit. As a result, data were only collected from six of the eight pins originally placed. Between the first and third observation sessions, a small amount of deposition occurred at one pin site, erosion had occurred at four, and negligible change was observed at one. Deposition was noted only on the dune ridge in the northeast end of the study site, while erosion was observed in the hummocky dunes in the south and north ends of the park and the slipface and dune ridge adjacent to the northeast boundary of Rosy Mound Natural Area (figure 6).

Pin number:	Erosion or deposition:	Amount (cm):
1	Erosion	1.8
2*	(negligible) erosion*	0.1*
3	Erosion	1.3
4	Erosion	0.9
5	Deposition	1.1
6	Erosion	1.0

**

Figure 6: Erosion pin data and locations in the study site.
*Erosion at pin 2 was not considered a significant result, as the measurement was so low as to be negligible. It was therefore not included in erosion pin analysis.
**Pins 7 and 8 were located on the 84.12 re W* n 83.07 341.34 84.

6.2

The sizes of studied *C. pitcheri* varied (figure 8), with the greatest fraction of them (36%) falling within the range of 10-20 F P O H Q J W K I R U W K H leaf. The sample size observed for leaf length comprised 82% of the plants analyzed, as it excluded the 29 dead *C. pitcheri*. From the leaf length data, we were able to determine that most of the thistles were at fairly low mortality risk at the time of analysis (based on / R Y H O O ¶ V (1984) findings in Good Harbor and Sleeping Bear Park (Appendix A)). Of the thistles observed, 31% were in the lowest risk group of 20-30 cm leaf length (table 3), while a full 76% were below a 10% mortality risk.

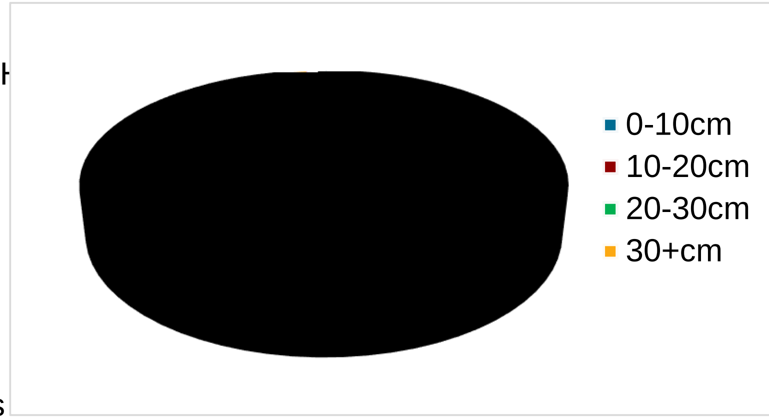


Figure 8: Leaf length distribution of observed *C. pitcheri* plants in the study site.

The populations indicated in the 20x50 m areas (figure 9) (collectively containing 53.8% of the total mapped) were analyzed and compared based on location relative to specific features. Observations indicate the presence of 30 thistles in the boardwalk proximity, 32 in the human unmanaged trail region, and 37 within the deer trail area. A fourth location in the open dune area served as a control area and contained 42 thistles at the time of analysis.

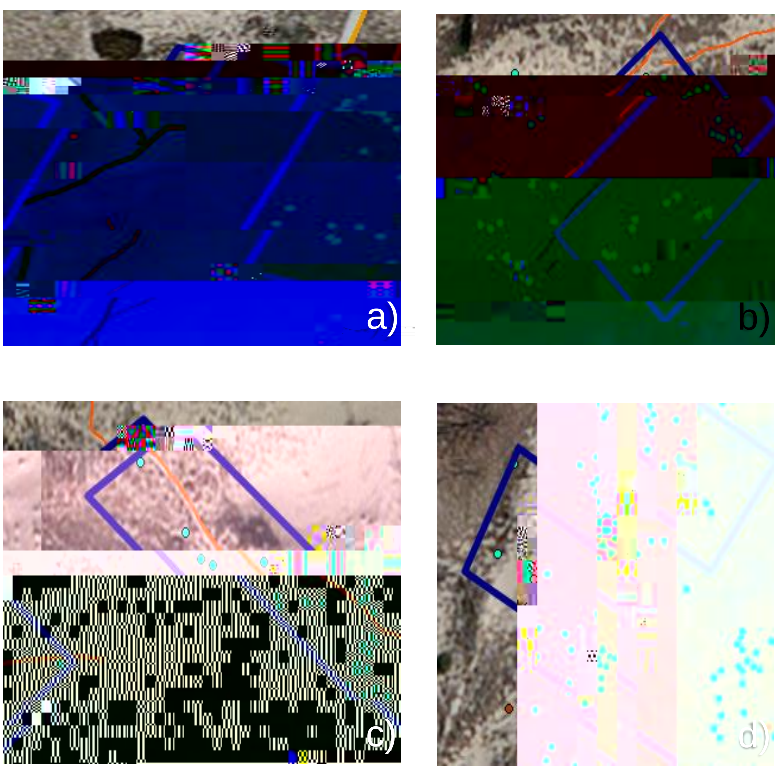


Figure 9: The observed *C. pitcheri* population clusters were adjacent to a) the boardwalk, b) a human unmanaged trail, c) a deer unmanaged trail, and d) an open dune area.

By comparing our studied population to Loveless's, we determined Rosy Mound Natural Area's thistles to be healthy, having a low mortality risk. This we attributed to a favorable size class distribution.

7.2 Unmanaged trails, deer evidence and influences

Since the widest unmanaged trail (figure 11) branched directly off the boardwalk, we infer it was human-caused. The trails along the north arm of the blowout were surmised to be deer trails as they were narrower and did not connect to the boardwalk. *C. pitcheri* was recorded in profusion in the vicinity of both sets of unmanaged trails, with a greater density in the proximity of the deer trail. While the greatest density was observed in the open dune area, the margin of divergence was very low – a count of only 12 plants separated the sparsest grouping from the densest.

Our results are consistent with Yorks et al.'s (1997) findings that forbs such as *C. pitcheri* are only surpassed in resistance to trampling by trees, graminoids, and cryptophytes. In their resilience (ability to recover following destructive impacts), they outstrip all but graminoids and cryptophytes. This is likely the reason there was so little divergence between the densities of the observed population groups.

The significant lack of grazing (and – to a large extent – trampling) damage to the *C. pitcheri* both within and outside the proximity of trails, coupled with the relative abundance of thistles in Rosy Mound Natural Area, suggests the environment's suitability

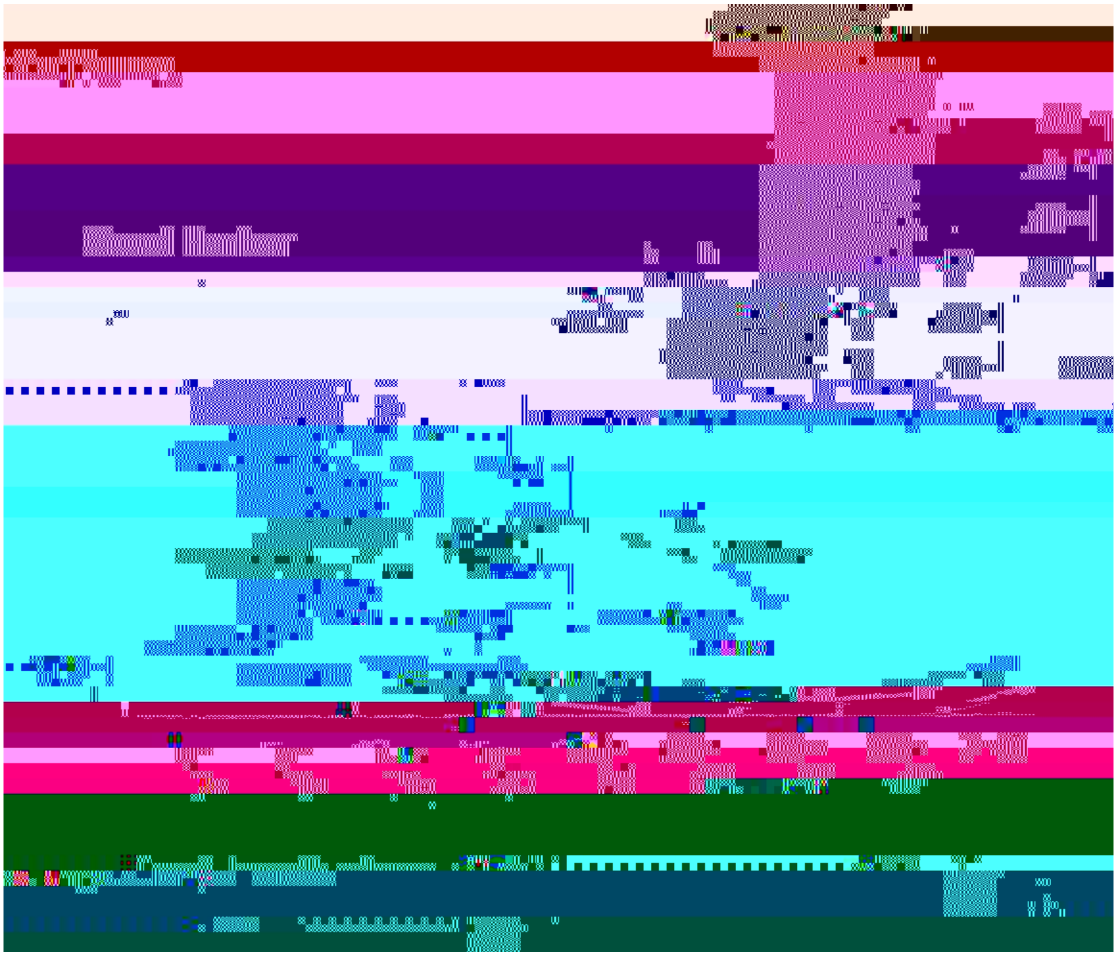
9.0 Acknowledgements

The research team thanks Ottawa County Parks for the use of their land for the duration of the study and Melanie Manion, Natural Resources Management Supervisor, for her support and assistance with this project. We extend our gratitude to Dr. Deanna van Dijk for invaluable mentorship and guidance throughout the research process. Our thanks go also to the National Science Foundation (Grant #0942344) and the Michigan Space Grant Consortium for the funding of this study and to the Calvin College Department of Geology, Geography, and Environmental Studies for the provision of this exceptional research opportunity.

10.0 Works cited

%HYLOO 5/ 6 0 /RXGD DQG / 0 6WDQIRUWK ion from Natural Enemies in ³3URWHFW

Appendix A: / R Y H O H V V¶ *Cirsium pitcheri* mortality findings



Graph reproduced from Loveless (1984 figure 6)