

# First-Year Research in Earth Sciences: Dunes



## **The Relationship between Physical Accessibility and Scenic Experiences on West Michigan Coastal Dunes**

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**FYRES: Dunes Research Report # 23  
June 2016**

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## **Abstract**

As the North American population ages, researchers are beginning to ask questions about the accessibility of natural environments. However, no such studies have focused on dune environments. This study investigated the physical accessibility of west Michigan coastal dunes by examining the recreational trails at four Ottawa County Parks. We developed a weighted rating scale for trail accessibility based on different physical trail aspects. We applied the rating scale to recreational trails by collecting data on trail length, location, rest areas, parking lot connections, signs, trail width and slope angle. We also assessed the aesthetic experience of each trail by collecting data on dune environments and scenic views. The rating scale performed well in our field test and was able to distinguish between trails that were marked as accessible on maps and those that were not. The accessible trails scored higher on our rating scale, but they tended not to lead people to dune crests, views of the lake and a variety of dune environments. These results suggest that the aesthetic experience on west Michigan coastal dunes is not equally accessible to all people. Park managers should consider implementing trails that give all visitors equal access to high quality dune experiences.

## **Introduction**

Coastal environments, including dunes, provide wonderful recreational opportunities for residents and visitors. However, many people in the United States may not have the ability to enjoy the same opportunities due to disabilities or physical limitations. Recent studies have identified the importance of designing accessible trails in parks and forests that allow all people to experience the same scenic experience (O'Callaghan and Jurasz 1992; Brown *et al.* 1999). Yet there has been no study on the accessibility of dunes. Our study compares the aesthetic experience of accessible and other recreational trails in west Michigan dune environments.

Our study objectives are to:

- 1) Create an accessibility rating scale for dune trails,
- 2) Evaluate the accessibility and scenic experiences of individual trails, and
- 3) Compare the scenic experiences of accessible trails to other trails.

## Background

The issue of accessibility is an important topic, and one that in the future will only continue to grow. More than 53 million U.S. adults reported a disability in 2013, and the most frequently reported type of disability was mobility (Courtney-Long *et al.* 2015). In general, disabilities involving mobility were higher for adults 65 years of age and older (Courtney-Long *et al.* 2015). In 2010 the total population of people 65 and older made up 13 percent of the United States population; by 2014 this number had grown to 14.5 percent (Census Bureau 2015).

In the United States, federal regulations and standards for accessibility are outlined in the Americans with Disabilities Act, known as the ADA (Department of Justice 2010). The regulations were first put into law in 1990, and variously amended with the most recent revision occurring in 2010 (ADA.gov 2016). Accessible routes are required to “consist of one or more of the following components: walking surfaces with a *running slope* not steeper than 1:20, doorways, *ramps, curb ramps* excluding the flared sides, elevators and platform lifts” (Department of Justice 2010: 117). Components such as ramps are permitted to be more steeply sloped than the walking surface (Department of Justice 2010). The guidelines also require that the “*cross slope* of walking surfaces shall not be steeper than 1:48” (Department of Justice 2010: 117). Chapter 10 of the ADA focuses on recreational facilities and states that unless “specifically addressed in Chapter 10, all other ADAAG provisions apply to the design and construction of recreation facilities and elements” (Department of Justice 2010: 224). Topics covered in that chapter include amusement rides, boating facilities, exercise equipment, golf facilities, play areas, swimming pools and shooting facilities (Department of Justice 2010). Recreational areas such as nature parks are not described in the standards.

Participation and limitations experienced in outdoor recreation activities are different for people with mobility disabilities and those without any mobility disabilities. A survey by Williams *et al.* (2004) found that people with a physical disability were far less likely to perform physically demanding activities such as hiking. Burns and Graefe (2007) used telephone surveys to provide an understanding of how disabilities hinder outdoor recreation participation; they found that 60 percent of households with a disabled resident were inhibited in their National Forest visits. Surveys by Muñoz-Santos and Benayas (2012) in the Smokey Mountains evaluated perceptions and attitudes of people with disabilities and their experience in the park related to physical accessibility. Accessibility problems ranged from having difficulty with the width of the

doorways in restrooms, to the lack of accessible trails, and the lack of curb cuts (Muñoz-Santos and Benayas 2012). Although these studies assessed the issue of accessibility for people with disabilities, they were based on qualitative surveys and did not assess the trails themselves.

Several studies give general guidelines, definitions, and ways to determine a trail's accessibility. The Americans with Disabilities Act defines accessibility based on level of development, slope, width, passing space, surfacing, rest space, and cross slope (ATBCB 1994). The ADA provides suggestions for trail signs, hand rails, stairs, gates and entry ways, and edge protection (ATBCB 1994). Procedures are also given for determining the highest degree of accessibility for new and existing paths. The ADA provides information on accessibility for: parking lots, restrooms, drinking fountains, and trashcans, benches, scenic overlooks, and handrails (ATBCB 1994). Chesney and Axelson (1994) designed a quantitative system for evaluating accessibility in outdoor environments for hiking trails. Their study identified five surface characteristics that affect a wheelchair: presence of obstacles, grade, cross slope, width, and surface type. Chesney and Axelson (1994) also stated that ADA requirements should not be applied to outdoor environments, and that design guidelines should be created for outdoor environments. However, Chesney and Axelson's (1994) trail evaluation system was complicated, slow, and limited in testing.

Although these studies did look at quantitative measures for determining the level of accessibility they did not evaluate the scenic experiences found along those trails. A study by Brown *et al.* (1999) looked at favorite types of natural areas for people with disabilities. They found the primary preferences were that of forested scenes over open field areas and that within these areas pictures with paths are preferred over pictures without paths (Brown *et al.* 1999). Studies such as these looked separately at determining the level of accessibility and identifying scenic experiences preferred by people with disabilities. Dune environments have not been included in either investigations of trail accessibility or investigations of scenic experiences preferred by people with disabilities.

## Study Area

Our study took place along the coast of southeast Lake Michigan at four Ottawa County parks. The parks studied were: Rosy Mound, North Ottawa Dunes (our study focused on the North Beach dune), Tunnel Park, and Kirk Park (Figure 1). Each park provided unique dune environments with many recreational trails. North Beach dune provided a large parabolic dune. Tunnel Park has a large established dune ridge. Rosy Mound has hummocky dunes, blowouts, and large wooded parabolic dunes. Kirk Park also has parabolic dunes and an active blowout.

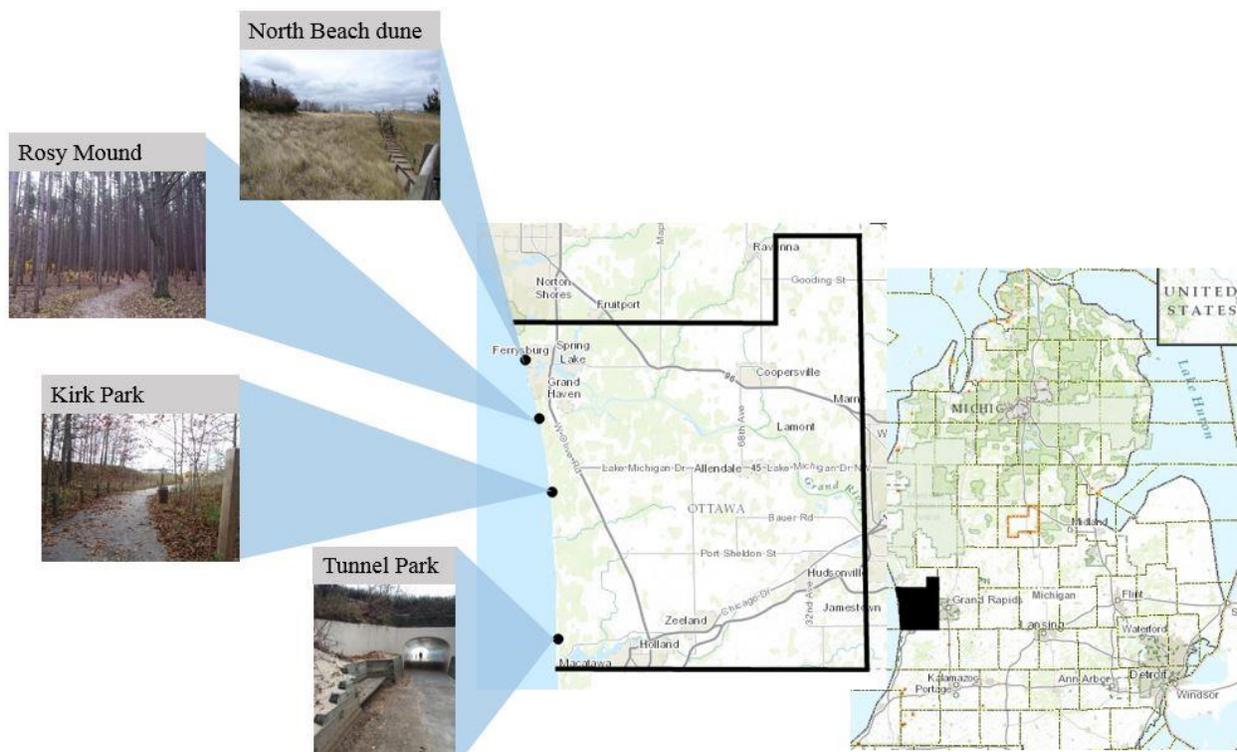


Figure 1: Location of the four parks on the east coast of Lake Michigan.

## Methods

Our research team used a number of different methods to investigate the accessibility of trails in each of our study areas. Each study area was visited once during the fall of 2015. Our study methods were consistent at each of our study areas and along each trail. We assigned team members with evaluating specific aspects along each trail for consistency.

### *Defining Trail Categories*

Our research began by defining the difference between recreational trails that would be considered accessible and those that would not. “Accessible” trails are defined as trails that are marked as accessible on park maps or signs along the trail. Any trails that are not specifically designated as accessible are termed as “other”. All mapping and documentation focused on trail segments which are defined as “the visible path from one trail intersection to the next” (Vander Bilt *et al.* 2013: 12).

### *Creating the Trail Accessibility Rating Scale*

We created a weighted point-system scale to rate the accessibility of trail segments. Decisions about what variables to include in measuring trail accessibility were based on a review of relevant literature (Table 1). Out of consideration for speed and clarity during use of the rating scale, some variables such as cross slope were not included. Our system weighed the individual variables measured according to their importance for accessibility. The weighted point system for each variable was based on researcher observations during previous dune fieldwork and existing standards.

Trail Variable	Standard Used	Measurement Tool
Trail length, rest areas, signs, and stairs	Created	GPS units
Trail width	USFA (2013)	Tape measure
Trail slope	USFA (2013)	Brunton compass
Dune environment	Created	Observation chart

Table 1: Different standards and tools used to evaluate trails.

### *Selecting Trails for Study*

Field research began by locating the accessible and other trail segments in the park that would be studied. This was achieved by looking at the park maps found both online and at each park. All accessible trail segments at each study location were studied. In most study areas, there were too many other trail segments to study all of them. In these situations, a variety of different trail segments were selected by researchers to represent the different environments present. For example, if a dune environment had an area where many trail segments were running through 3 different environments, then at least one trail from each environment was selected for study. We mapped and measured each trail according to where it was marked by signs. If trail signs were not seen where trail maps indicated they would be, we approximated the starting location according to landmarks found on the map. If a trail was marked as ending right before a set of stairs, those stairs were included in the measurement of the trail.

### *Inspecting trails*

Based on the accessibility rating scale we created, we identified important variables that could impact a trail's level of accessibility. GPS units were used to map each trail's overall length, as well as the locations of rest areas, benches and signs. Every fifty meters along each trail, the team measured the slope and width of the trail and recorded trail surface type. The maximum and average slope of the trail segment was measured using a Brunton compass and the width was taken using a standard tape measure. For areas where the trail edges were not clearly distinguished (i.e., a dirt path) an approximation was made by the researcher. We also recorded the following along each trail: number of stairs, whether the trail is located before any stairs, and whether the trail is accessible from the parking lot.

### *Assessing the Scenic Experience*

We developed and implemented an observation chart to document the different scenic experiences found along each trail segment (Table 2). The questions are based on scenic experiences that are distinctive to dune environments. We completed a chart for each trail segment. The completed chart was paired with any other notes the research team made about the trail segment and some photographs.

<b>Observation Chart</b>	
Does the pathway go through a wooded area?	
Is there visible sand along the trail?	
Is there a lookout point?	
Does the trail lead to the top of a dune?	
Is there a view of Lake Michigan?	
Is the beach visible from the trail?	

Table 2. Scenic observations chart for each trail.

### *Analyzing Trails*

For evaluating all of the trails, we employed our 34-point rating scale to quickly tabulate and assign a point value to each individual trail. This quick tabulation of scores allowed our team in the field to make sure that the point values from the rating scale appeared to match up with the researcher's experience of how easily accessible the trail was. It also later gave us the ability to easily compare the results between different trails and parks.

### *Data Analysis*

Trail characteristic data was recorded in a field notebook and transferred into our Accessibility Rating Scale at the park. The scores and data were later entered into an Excel spreadsheet and then plotted and compared visually. GPS locations of trails, rest areas, signs, and stairs were downloaded to the GPS Pathfinder Office software and uploaded into ArcMap 10.1. In ArcMap the data provided visual representations of the trails we had mapped.

## Results

### *Accessibility Rating Scale*

We produced an Accessibility Rating Scale that can be used to determine if a trail is accessible or not in coastal dune environment (Table 3). To employ the rating scale, a researcher needs to measure or observe trail characteristics such as slope, width, access to parking lot, and presence of stairs. A researcher only needs a tape measure, device for measuring slope (e.g., a Brunton compass) and a device for measuring distance (e.g., GPS or rolling distance measurer). The points assigned to different trail characteristics permit a researcher to calculate an accessibility points total for the trail segment. Our research team, which consisted of four members, assessed 3 trail segments per hour.

Trail Characteristic	Points
Trail Width (3 pts possible) Average of measurements taken every 50 meters: _____ cm <input type="checkbox"/> >48 in (122 cm) = 3 pts <input type="checkbox"/> 36-48 in (91-122 cm) = 2 pts <input type="checkbox"/> < 36 (91 cm) = 0 pts	
Trail Length (3 pts possible) As measured by GPS: _____ km <input type="checkbox"/> 0-1 km = 3 pts <input type="checkbox"/> 1-1.5 km = 2 pts <input type="checkbox"/> 1.5-2 km = 1 pt <input type="checkbox"/> > 2 km = 0 pts	
Maximum slope (3 pts possible) Measured with compass/level at steepest slope: _____ % grade <input type="checkbox"/> ≤10% = 3 pts <input type="checkbox"/> 11-14% = 2 pts <input type="checkbox"/> 15-20% = 1 pt <input type="checkbox"/> >20% = 0 pts	
Average slope (3 pts possible) Averaged from slope measurements every 50 meters: _____ % grade <input type="checkbox"/> ≤5% = 3 pts <input type="checkbox"/> 6-8% = 2 pts <input type="checkbox"/> 9-12% = 1 pt <input type="checkbox"/> >12% = 0 pts	
Is there a rest area or bench present? (2 pts possible) <input type="checkbox"/> At least 1 = 2 pts <input type="checkbox"/> None = 0 pts	
Type of Trail Surface (4 pts possible) <input type="checkbox"/> Hard = 4 pts <input type="checkbox"/> Moderate = 3 pts <input type="checkbox"/> Soft = 2 pts <input type="checkbox"/> Very Soft = 0 pts	
Are Signs Present? (1 pt possible) <input type="checkbox"/> Yes = 1 pt <input type="checkbox"/> No = 0 pts	
Trail is accessible from parking lot? <input type="checkbox"/> Yes = 5 pts <input type="checkbox"/> No = 0 pts	
Ramps or stairs present? (5 pts possible) <input type="checkbox"/> Ramp(s) present or no stairs = 5 pts <input type="checkbox"/> < 50 stairs = 3 pts <input type="checkbox"/> >50 stairs = 0pts	
Trail is located before any steps? <input type="checkbox"/> Yes = 5 pts <input type="checkbox"/> No = 0 pts	
Total Points (34 possible points)	

Table 3. Accessibility Rating Scale

In the Accessibility Rating Scale, variables are weighted by the different amounts of points that are assigned to each variable (Table 4). A higher point total indicates greater influence on accessibility. Primary variables, which have the largest maximum points possible, play deciding roles for whether trail segments are accessible or not. A trail is simply not accessible if one cannot get to it from a parking lot or has to use stairs to access the trail. Secondary variables are important because of their effect on the trail's level of difficulty. A low-sloped, wide, hard-surfaced, short trail is easier to traverse than one that has sandy surfaces, steep slopes, and is long and narrow. Tertiary variables have the lowest point values, as they do not play an important role with the level of difficulty or accessibility. Rather they make the experience on the trail more pleasant, by providing clear signs and rest areas. The primary variables impact the scores on a rating scale most, followed by the secondary and then the tertiary variables.

<b>Variable importance</b>	<b>Trail variable</b>	<b>Maximum points</b>	<b>Reason for points</b>
Primary	Accessible to parking lot	5	Reduces difficulty for accessing trails
	No stairs before trail	5	Extremely difficult to impossible for wheelchairs to navigate stairs
	No stairs on trail	5	
Secondary	Types of trail surfaces	4	Ease of walking and rolling wheelchairs
	Trail width	3	Ease and ability for walkers and wheelchair use on trail
	Trail length	3	Fatigue created by longer trails
	Maximum slope	3	A lower slope makes the trail less strenuous and less difficult to traverse
	Average slope	3	
Tertiary	Rest areas	2	Gives places to regain energy
	Signs	1	Allows visitor to easily locate trail and stay on correct trail

Table 4: Accessibility Rating Scale variables as ranked by importance to trail accessibility.

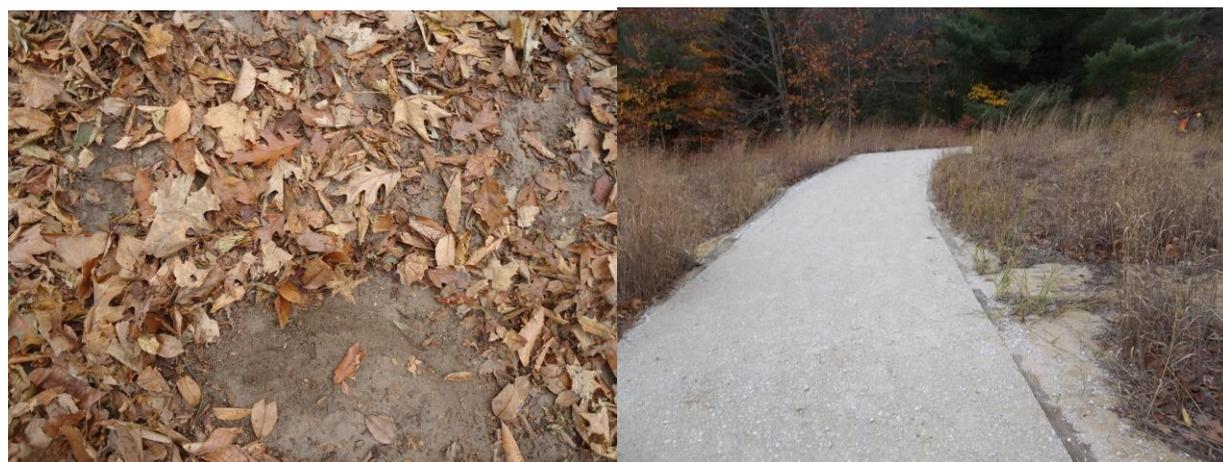
## Trails

We assessed eighteen trail segments of which seven were accessible and eleven were other trails. Each park had 2 accessible trail segments, except for the North Beach dune where there was only one. Nearby North Beach Park does have a seasonal accessible trail segment on the beach, but it had been removed before our study. At every park there were 3 other trail segments studied except for in Kirk Park where there were only 2 studied.

Trail characteristics showed considerable variability (Table 5). The surface of the trails ranged from sand and dirt to asphalt and boardwalks made of wood (Figure 2). The average slopes of the trail segments ranged from 0% all the way up to 26%. Ten trail segments had no stairs and eight trail segments had stairs with number of steps ranging from 43 to 477.

Park	Type of Trail	# of Trails	Maximum Slope (%)	Average Slope (%)	Surface	# of Stairs	Access from Parking	Stairs Before/On
Rosy Mound	Accessible	2	12, 10	4, 3	gravel	0, 0	yes, yes	no, no
	Other	3	42, 45, 5	14, 16, 2	gravel-wood	116, 43, 0	no, no, no	yes, yes, yes
North Beach	Accessible	1	2	2	wood	0	yes	no
	Other	3	49, 2, 25	24, 60	wood-dirt/sand	142, 253, 50	yes, no, yes	yes, yes, yes
Kirk Park	Accessible	2	4, 9	4, 4	asphalt	0, 0	yes, yes	no, no
	Other	2	70, 8	20, 6	dirt/sand	477, 0	no, yes	yes, no
Tunnel Park	Accessible	2	4, 0	2, 0	concrete	0, 0	yes, yes	no, no
	Other	3	0, 0, 3	0, 0, 2	wood-sand	66, 0, 75	yes, no, no	yes, yes, yes

Table 5: Trail characteristics recorded for each park's accessible and other trails.



a)

b)

Figure 2: Examples of trail surfaces include a) a dirt other trail (soft surface) in Kirk Park and b) a gravel accessible trail (hard surface) in Rosy Mound Natural Area.

Some trail characteristics were distinct between accessible and other trails. If the trail segment was accessible, it had 0 stairs. Other trail segments had 0 to 477 stairs (Figure 3). All accessible trails had access from a parking lot. Among other trails, there were 7 that had no access from a parking lot and only 4 with access from a parking lot.



Figure 3: Stairs on one of the other trails in Rosy Mound Natural Area.

Scores for accessible trails averaged 14.5 more points compared to scores for other trails (Figure 3). Out of the 34 total possible points, no accessible trail scored below 31 and only one other trail scored over 23. Based on these results, we identified a score of 25 on the Accessibility Rating Scale as the dividing line between accessible trails (scores greater than 25) and other trails (scores with 25 points or less).

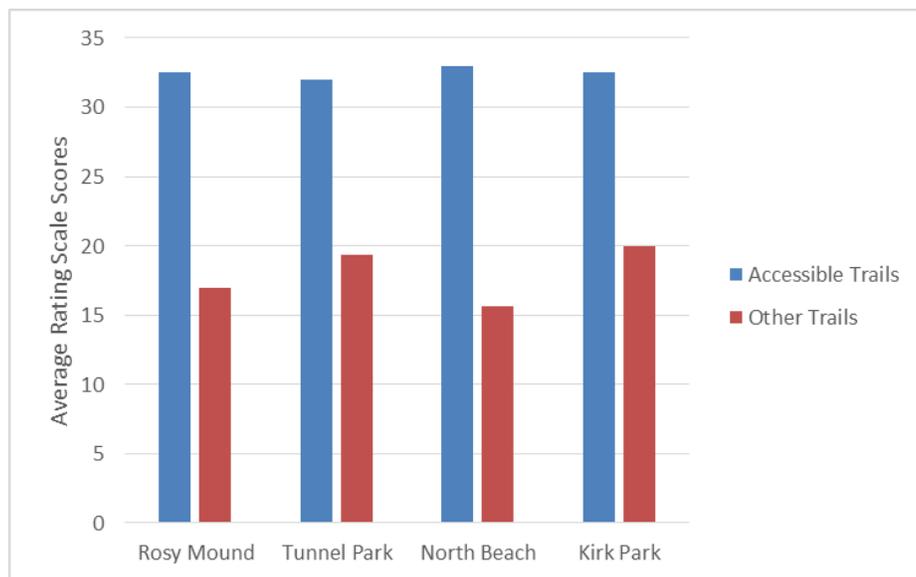


Figure 4: Average accessibility scores for accessible and other trails in each park.

### *Trails and Scenic Experiences*

In Rosy Mound Natural Area, we mapped and assessed 2 accessible trails and 3 other trails (Figure 5). On both of the accessible trails, wooded areas and visible sand were observed. Visible sand was observed on all three trails, while wooded areas and a lookout point were recorded on two trails. On one trail there was a view of Lake Michigan and the beach as well as access to a dune crest.

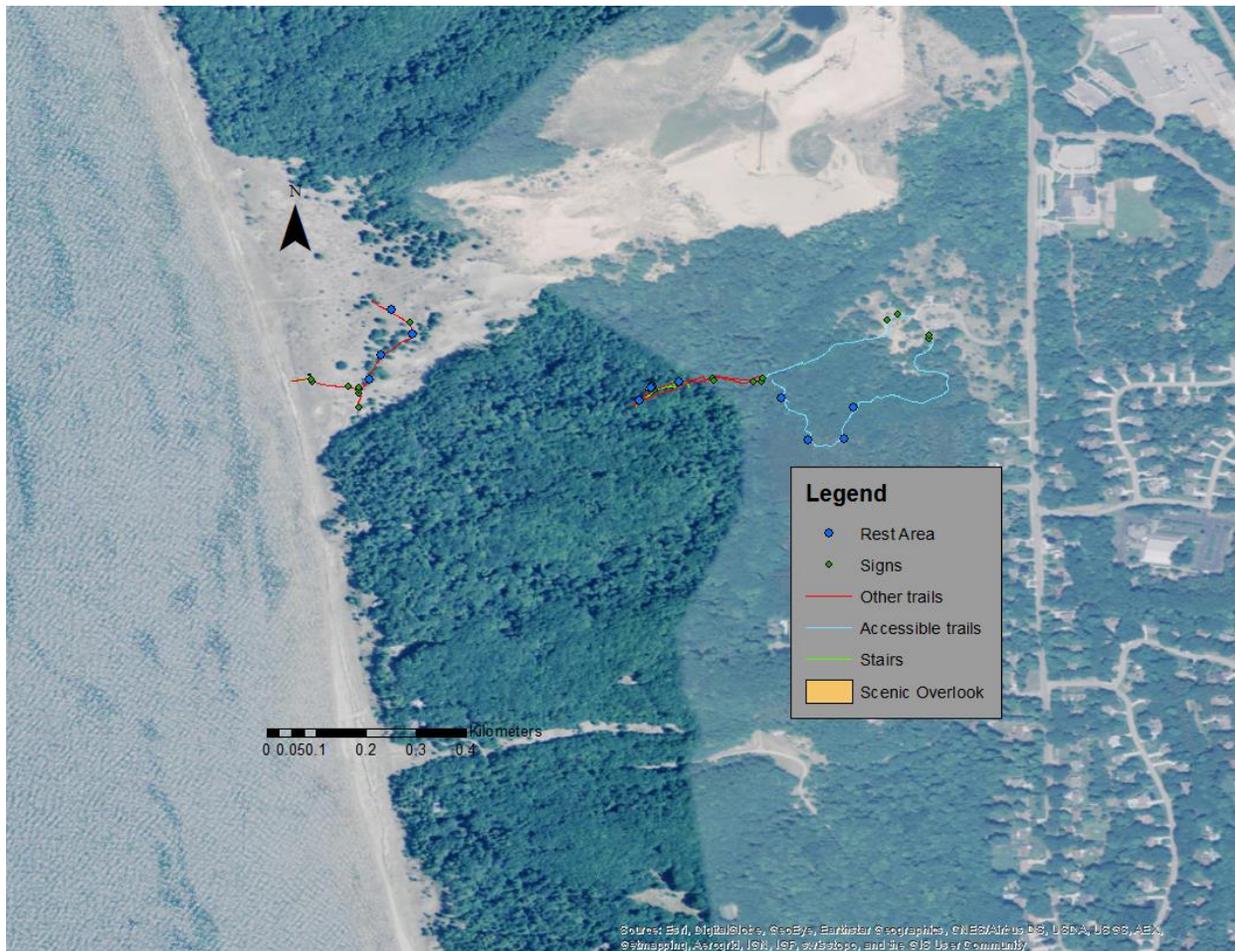


Figure 5: Mapped trails and their features at Rosy Mound Natural Area.

In Tunnel Park, we mapped and assessed 2 accessible trails and 3 other trails (Figure 6). The accessible trails included all types of scenic experiences except for access to a dune crest. All of the other trails measured at Tunnel Park had access to a dune crest and visible sand on the trail. Two of the other trails had lookout points and beach visibility occurred. A view of Lake Michigan and a wooded area occurred on one of the other trails.



Figure 6: Mapped trails and their features at Tunnel Park.

On North Beach dune, we mapped and assessed 1 accessible trail and 3 other trails (Figure 7). The accessible trail is a short segment that gives visitors visual access to the bottom of the dune's windward slope. Scenic views on the accessible trail included visible sand, a view of Lake Michigan, and a lookout point. Scenic experiences on the other trails included wooded areas, visible sand, beach visibility, and a view of Lake Michigan. Only two of the other trails had lookout points and one trail had access to a high dune crest.



Figure 7: Mapped trails and their features at North Beach dune.

At Kirk Park, we mapped and assessed 2 accessible trails and 2 other trails (Figure 8). The accessible trails had wooded areas and visible sand along the trails, a view of Lake Michigan and a lookout point. Access to a dune crest occurred only once along these trails, and neither trail had beach visibility. Both other trails had wooded areas and visible sand. Between the two other trails, each of the remaining scenic observations were seen once.

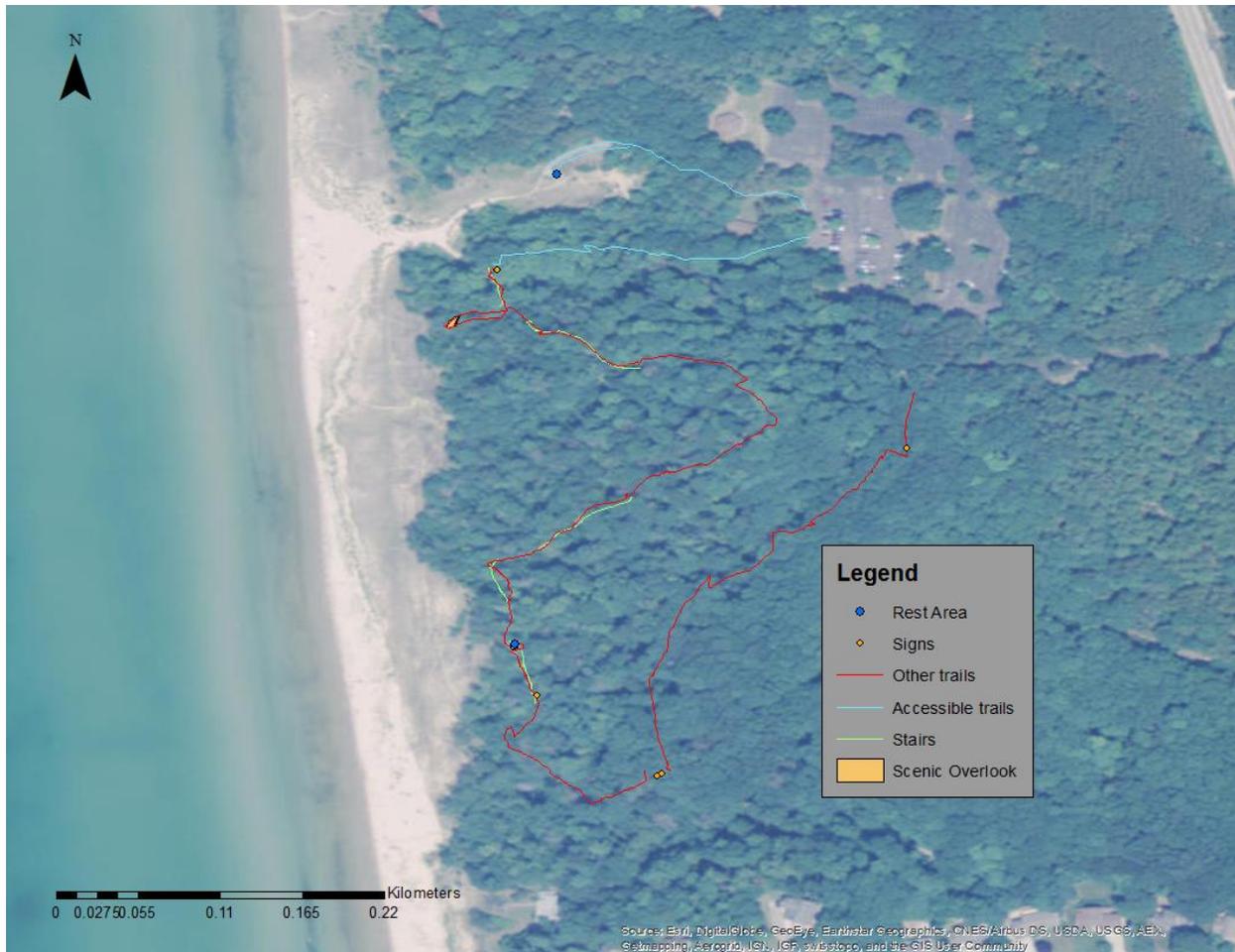


Figure 8: Mapped trails and their features at Kirk Park.

A comparison of types of trails with scenic experiences shows that accessible trails had less scenic experiences than other trails (Figure 9). The difference is the greatest for the experiences of being at the dune crest or being able to see the beach from the trail. The scenic experiences of accessible trails and other trails are most similar in the category of wooded areas.

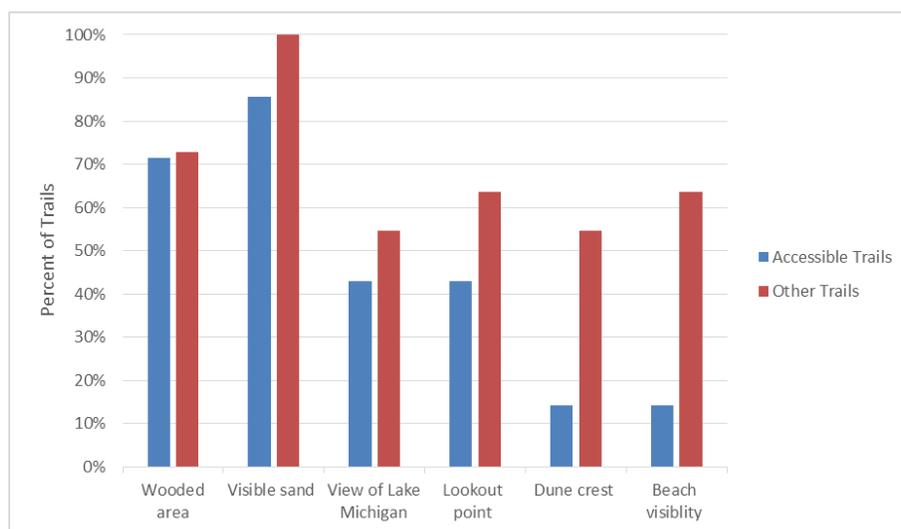


Figure 9: Percent of trails where each type of scenic experience was found.

## Discussion

Our Accessibility Rating Scale was effective at quickly determining the level of accessibility and allowed us to easily compare the accessibility levels between trails. Comparing designated accessible trails (i.e., trails identified as accessible by Ottawa County Parks) to those that were not accessible allowed us to test whether this new rating scale was accurate in identifying accessible trails. Our result that scores over 25 should be considered accessible shows that the rating scale enables quick comparisons and is accurate in assessing the accessibility of trails.

When comparing accessible trails to other trails we found that the accessible trails did not have the variety of scenic experiences as the other trails had (Figure 10). These results agree with previous studies that indicate trails with aesthetically pleasing views are often inaccessible to those with disabilities and health conditions (Burns and Graefe 2007). Park managers and planners should consider providing accessibility to all types of dune environments. However, accessibility does not have to be expensive. O'Callaghan and Jurasz (1992) state that, in the



Figure 10: View from a trail in Kirk Park with a low accessibility score but a high scenic observation rating.

process of designing buildings, meeting accessibility specifications only adds 1 percent to the total cost; renovating buildings later adds up to forty percent to the cost.

We recommend the following topics for future studies to test and expand the results of our pioneering study:

- Employ the rating scale in different dune environments
- Add more points of data collection per trail segment
- Modify point values of variables to reflect impact each variable has on the level of accessibility
- Determine other variables that affect accessibility and should be included
- Survey people with physical limitations to determine what dune environments they find most aesthetically pleasing.

Further refinements to the Accessibility Rating Scale will make it even more useful.

## **Conclusions**

Our study successfully created a rating scale that is effective at evaluating the level of accessibility for trails in dune environments. We applied the scale to 18 trail segments in 4 parks with a variety of Lake Michigan dune environments. Accessible trails scored high on the rating scale and other trails scored much lower. Accessible trails also offered a lower percentage of aesthetically-pleasing environments when compared to other trails. Park managers should consider implementing trails that give all visitors equal access to high quality dune experiences.

## **Acknowledgements**

Thank you to the Michigan Space Grant Consortium and Calvin College for funding this project. We also thank the Ottawa County Parks and Recreation Commission for allowing us access to their wonderful dunes. Finally, thanks to Dr. Deanna van Dijk for assisting in this study.

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