First-Year Research in Earth Sciences: Dunes

The Impact of Deer on Unmanaged Trails in North Ottawa Dunes County Park

by Brian D. Hilbrands, Jesse L. Damsteegt, Brian P. Hess, Madeline G. Hughey, Jake A. McCusker, and Jacob C. Van Wyk

FYRES: Dunes Research Report # 14
May 2015

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

Abstract

The impacts of mammals such as deer on coastal dune geomorphology has received little attention from the scientific community. This study looked at the relationship between deer and unmanaged trails in a dune environment, including what influence deer might have on human use of unmanaged trails. The study site was a large parabolic dune in North Ottawa Dunes County Park. A main objective of the study was to investigate whether there was any differentiation in characteristics between deer trails and trails used by both humans and deer. At the study area, unmanaged trails were mapped using GPS units. Trail use was determined by observing the kind of tracks found on the trail and looking for litter and other signs of human use. Measurements for each trail segment included width, vegetation cover, and leaf litter. Deer activity such as individual tracks, deer droppings, and bedding areas were also mapped to identify where deer have been active. Results show that deer evidence was found across the dune, but more evidence was found in wooded areas than in the bare dune area. They also show a number of unmanaged trails going across the bottom of the dune and fewer trails on the higher, steeper slopes. Although the trails lacked vegetation, there were no observed local topographic changes. Also, most trails were exclusively used by deer. These results suggest that the creation of unmanaged trails by deer are not encouraging park visitors to leave the managed pathways and use the unmanaged trails.

Introduction

Coastal dunes are a very visible part of the landscape in a coastal environment and are also an important piece of that environment. They provide habitat for native species and recreational opportunities for residents. Each year there are efforts undertaken to stabilize or control dunes that are encroaching on developed areas. These efforts will often concentrate on reducing the bare area of the dune or the number of unmanaged trails on the dune. Such management efforts take place around the world, including in the Great Lakes region which is well known for its coastal dunes. Besides the dunes, white-tailed deer are another major part of the Great Lakes environment. Michigan has one of the largest white-tailed deer populations in the United States (Adams and Ross 2015), and deer can be found in a wide variety of environments including coastal dunes along the Lake Michigan shore. Even though there is often interaction between deer and dunes, there has been very little research conducted on the relationship between them. This study looks to examine that relationship more closely by looking at how deer behavior affects unmanaged trails in a coastal dune environment.

Objectives of the study include 1) mapping unmanaged trails and deer evidence in the study area, 2) recording trail characteristics and determining the relationship between deer and unmanaged trails, and 3) determining how deer behavior is affecting unmanaged trails, which in turn might be affecting the dune environment.

Background

The interaction between deer and coastal dune environments, and the impact deer have on dunes, are research topics that have not received abundant attention from the scientific community. Previous research tended to focus on the impact of deer on vegetation, such as the study performed by Inouye, Taber, and Johnson (1994) that focused on the effect of deer on vegetation succession on a Minnesota sand plain. Some of these studies do take place in coastal environments. For instance, Phillips and Maun (1996) examined the effect of simulated herbivory by deer on the survival of *Cirsium pitcheri* (Pitcher's thistle), which can be found on Great Lakes dunes. A separate project undertaken by D'Ulisse and Maun (1996) attempted to identify environmental factors that affect the growth of *Cirsium pitcheri*; their work determined that predation by deer had a major effect. An additional study by Gedge and Maun (1994) investigated the effect of simulated deer herbivory on two dune annuals. While these studies all involve deer in a coastal environment, they do not address the impacts of deer on the dune themselves, only their effect on vegetation.

Other studies of deer in dune environments include the examination of the role of deer in the dispersal and growth of ectomycorrhizal fungi (Ashkannejhad and Horton 2006) and the indirect effect of deer herbivory on nitrogen availability (McNeil and Cushman 2005). Ashkannejhad and Horton (2006) determined that deer actually aid in the dispersal of fungi spores. McNeil and Cushman (2005) concluded that deer herbivory had a direct effect on the quality of leaf litter, which in turn had an indirect effect on the nitrogen in the soil. An unpublished study that does investigate the relationship between deer and trails was done by Lui *et al.* (2014). Their study indicated a positive relationship between deer activity and the creation of trails in dune environments.

Human impacts on dunes is another topic that has seen some substantial research completed. A number of studies have been conducted that examine the impact of human trampling on vegetation (Andersen 1994; Bowles and Maun 1982; Hylgaard 1980; Santoro *et al.* 2012). Human trampling has been shown to have a negative impact on coastal dune vegetation as it can reduce the amount of vegetation cover as well as decrease the diversity of plant species. Other studies by Burden and Randerson (1972) and Hylgaard and Liddle (1981) examine the impact of human trampling on both soils and ground vegetation. They found that trampling not only damages vegetation, but it can also negatively affect the dune itself. While these studies demonstrate the negative effect human trampling can have on a dune environment, the possible effects of deer are not included.

Study Area

Our study area is located in North Ottawa Dunes County Park. The park is located on the west coast of Michigan near the town of Ferrysburg (Figure 1). North Ottawa Dunes consists of 2 km^2 (513 acres) of coastal dune habitat and includes eight distinct dunes that exceed 225 m (750 feet) in length (Ottawa County Parks & Recreation 2015). Our study area was concentrated around the southernmost of these, North Beach dune. North Beach dune is a partially wooded parabolic dune with an open windward slope that reaches a height of 45 meters (Jamieson and van Dijk 2004). The study area was located along the western edge of the dune and incorporated the bottom half of the slip face as well as adjacent wooded areas to the north and south.

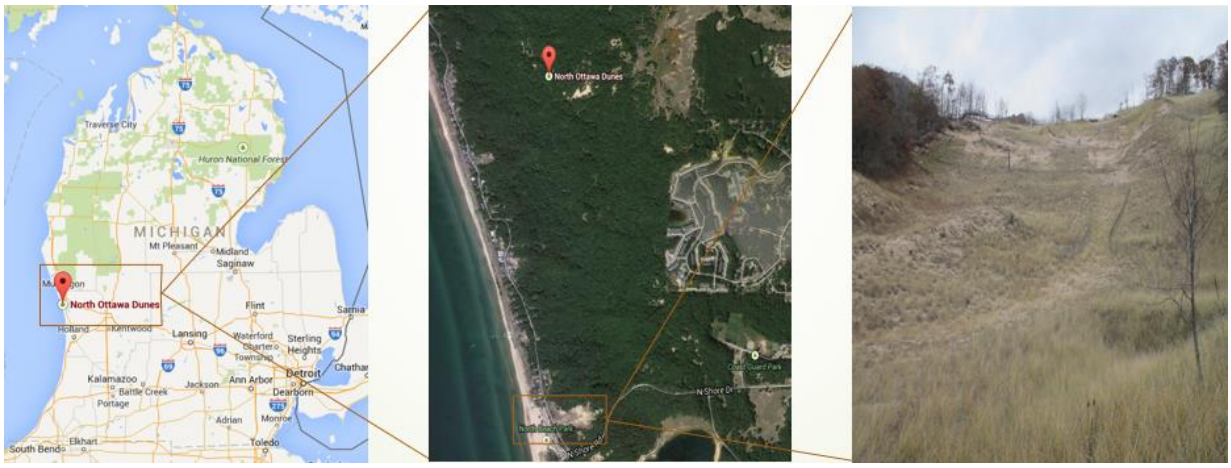

Figure 1. The location of North Ottawa Dunes County Park on the west coast of Michigan, the location of North Beach dune within the park, and the open windward slope of the dune.

In North Ottawa Dunes, there has already been some history of deer and dune interaction. A 2007 study conducted by park officials and Grand Valley State University concluded that the population of white-tailed deer in the park was too large and was not able to sustain a healthy ecosystem (Chandler 2012a). Ottawa County Parks Director John Scholtz is quoted as saying: "The near elimination of understory plants at the park not only threatens the regeneration of the park's forest, but is an immediate threat to all animals needing the food and shelter provided by small trees, shrubs and wildflowers" (Chandler 2012a). In order to curb the deer population and allow for the regrowth of vegetation, the park allowed a controlled hunt in 2012 that saw a total of sixteen deer taken during the two weekends of hunting (Chandler 2012b). Since then there have also been hunts conducted in 2013 and 2014. Local residents and opponents of the hunt believe that the hunts have been unnecessary. They argue that an independent study of the ecosystem should be undertaken, as well as a deer population survey to try and determine the actual size of the deer population in the park (Chandler 2012b).

White-tailed deer are not the only aspect of the North Ottawa Dunes environment that may be causing changes. Until recently, North Beach dune has been a very active dune that was

advancing at a rapid rate towards an access road that was the only point of access to numerous houses along the lakeshore. In 2004 the dune was advancing at a rate of 0.67 m/year (Jamieson and van Dijk 2004). A number of unmanaged trails running along the face of the dune were determined to be one of the factors creating the quick advance rate. Numerous management efforts were then put into place that focus on decreasing the number of unmanaged trails along the dune (Figure 2). These efforts include the planting of *Ammophila breviligulata* (American beach grass), the creation of a boardwalk to the top of the dune in 2008, management signs, and the installation of sand fences in 2007 across the face of the dune to discourage park visitors from climbing the face (Parkin *et al.* 2012). In 2012, the dune advance rate was measured at 0 m/year (Parkin *et al.* 2012).

Figure 2. North Beach dune with sand fences along the face of the dune.

Methods

Our research team used a variety of methods to investigate the impact of deer on trails in our study area. In total we made four trips out to the study area, three in the fall (October-November 2014) and one in the winter (January 2015). Study methods remained consistent between the fall and winter research trips. Researchers divided into teams of two and scoured the study area for unmanaged trails and signs of deer evidence. When found, trail characteristics were recorded and deer evidence and trails were mapped with the use of Trimble Juno GPS units to store their spatial locations.

We divided our study area into two focus areas: an open dune study area and a wooded dune study area. These areas were spread across the lower half of the face of North Beach dune. The open dune area was designated as the area within the boardwalk in the lower half of the dune. Adjacent wooded areas to the north and south comprised the wooded dune study area (Figure 3). The wooded dune area was approximately 16,400m^2 and the open dune area was

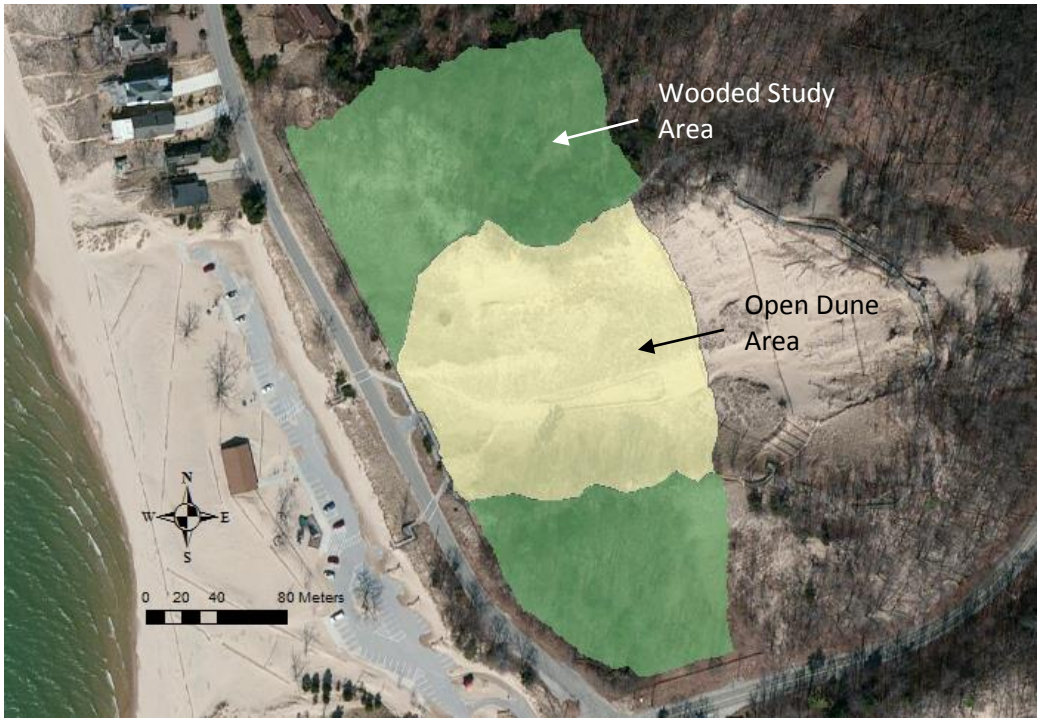

Figure 3. Map of open dune and wooded dune study areas.

approximately 8,760m^2. Both the open and wooded areas were included in the study to observe the impact deer might have on different parts of the dune environment.

Investigating Trails

We began our research by mapping unmanaged trails and deer evidence. Trails were mapped in segments. A researcher would follow a trail until it either tapered out or ran into another trail. If it ran into another trail then the researcher would begin mapping a new trail segment. Characteristics of each trail segment were then recorded to assess whether there were any noticeable differences between unmanaged trails being used by deer and those that were used by deer and humans (mixed-use). The use of the trail was determined mainly by the presence of tracks or footprints that could be found on the path. The presence of litter was also used as an indicator of human use of the trail. If there was any sign of human use along with evidence of deer, the trail was recorded as mixed-use.

Measured trail characteristics included width and length, track density on the trail, and the presence of vegetation and leaf litter. Trail width was measured using a folding ruler. Three measurements were taken along a trail segment and then averaged together to determine the width for that segment. Track density was measured by placing a 50cm by 50cm quadrat on the trail and counting the number of tracks that fell within the quadrat. Track density was measured at the location where the second trail width measurement was taken. The vegetation and leaf litter measurements were determined by the researcher on a scale similar to the one used by Liu *et al.* (2014) in their research. Based on a visual observation the researcher would give a

measurement from 1-5 for both vegetation and leaf litter presence (Table 1). Leaf litter presence was measured on the trail while vegetation was measured along the trail (within 1 meter of trail edge).

Vegetation Along Trail or Leaf Litter Presence on Trail		
Ranking	Vegetation	Leaf Litter
1	Bare sand	Bare Sand
2	Sparse vegetation	Sparse leaf litter cover
3	Moderate vegetation	Moderate leaf litter cover
4	Mostly vegetated	Heavy leaf litter cover
5	Fully vegetated	Complete leaf litter cover

Table 1. Relationship between the trail surface, vegetation near the trail, and leaf litter on the trail.

Deer Evidence

Deer evidence was mapped by researchers to gain an understanding of where deer were moving even if there was not an established trail. Deer evidence included droppings, bedding areas, scrapes, individual tracks and high-track-density areas that contained numerous individual tracks, but a trail could not be determined.

Figure 4. Trail camera used in the study.

We used a trail camera to see if deer were moving around the study area during the time of our research (Figure 4). We located the trail camera in the northwest corner of the study area along an unmanaged trail that showed evidence of use by deer. Because of logistical constraints, we were only able to have the trail camera operational for one week.

Analyzing Data

GPS locations of trails and deer evidence were downloaded to the GPS Pathfinder Office software where they were differentially corrected to increase their accuracy, and then uploaded into ArcMap 10.1. In ArcMap the data was mapped to provide a visual understanding of where deer activity and unmanaged trails were concentrated in the study area.

Results

Deer Evidence

Our group discovered and mapped numerous signs of deer evidence within our study area (Figure 5). Evidence was found in both the wooded and open dune study areas. Our trail camera provided us with four pictures of deer during its two weeks of operation (Figure 6). This allowed us to determine that deer were in fact moving through our study area during our research.

Figure 6. One of the trail camera images.

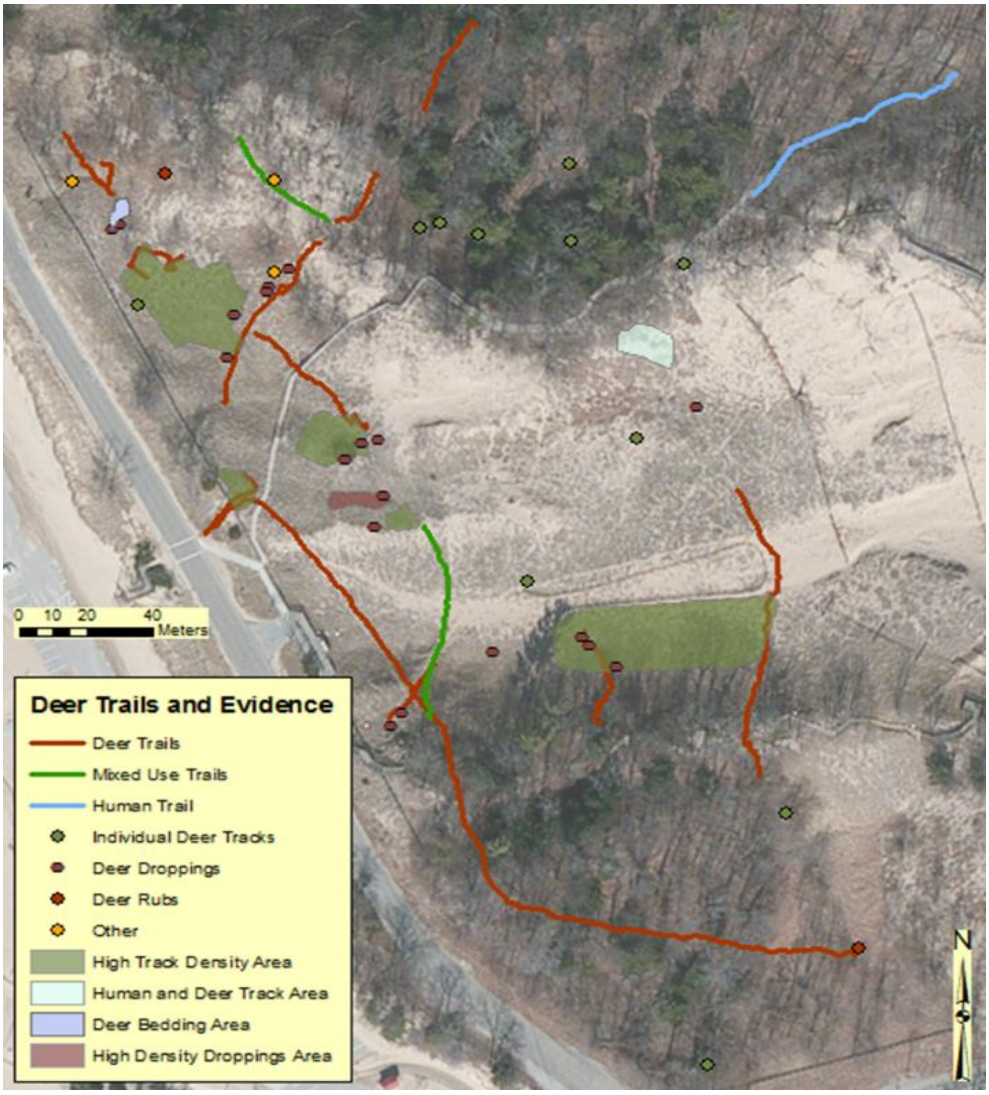

Figure 5. Map of deer trails and evidence.

Figure 7. A cluster of deer droppings.

Figure 8. An individual deer track.

In total, forty signs of deer evidence were recorded. The most common type of evidence was droppings. Nineteen clusters of deer droppings were recorded: ten in the open dune study area, and nine in the wooded study area (Figure 7). There were also 11 individual deer tracks mapped by researchers (Figure 8). Three of the individual tracks were also found in the open dune study area while the other eight were found in the wooded area.

Six high-track-density areas were mapped (see Figure 5). These were areas where a trail could not be determined, but scattered tracks still indicated there was deer movement in the area. Of these six high-track-density areas, one was a human and deer track area while the other five were solely deer track areas. Four of the high-track-density areas were found in the open dune area and the other two were located within the wooded study areas. Other deer evidence that was detected includes two deer rubs and one bedding area, all of which were found in the wooded study areas.

Trail Characteristics

Sixteen trail segments were recorded by researchers during the study. Trails were found across the study area in both the open dune and wooded areas (see Figure 5). We found that the heavy leaf litter in the wooded areas made it difficult to find trails in those areas. Of the sixteen mapped trails, only three were mixed or human use and the other thirteen were only being used by deer (Figure 9). This indicates that when the trails were mapped there was no evidence of humans along the trail.

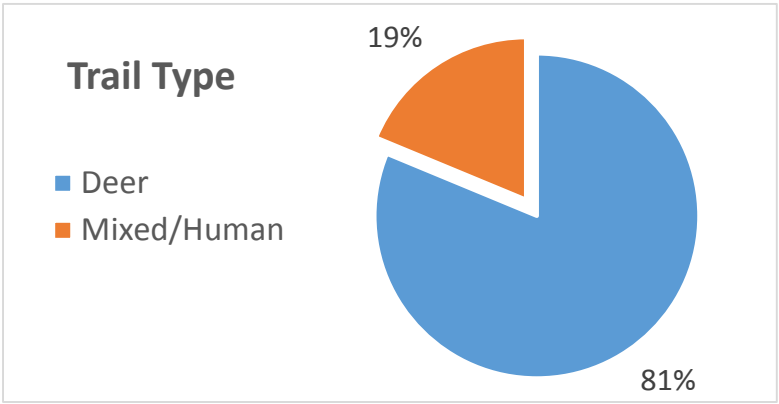

Figure 9. Percentage use of unmanaged trails.

Trail Type	Avg. Width (cm)	Vegetation	Avg. Length (m)
Deer	53.70	2.75	27.53
Mixed/Human	87.17	2.00	44.80

Table 2. Width, amount of vegetation, and length of unmanaged trails.

When comparing the deer trails and mixed-use trails, differences could be found between some of the trail characteristics (Table 2). A deer trail has an average width (53.70cm) that is almost forty percent narrower than the width of a mixed-use trail (87.17cm). More vegetation was recorded along trails used by deer. Average length of a trail used by deer was recorded to be 27.53m while the human and mixed-use trails had an average length of 44.80m. The measured characteristics and field observations showed that deer trails were less distinct or noticeable on the dune compared to mixed-use trails.

Winter Results

During the winter visit to the site on January 22, 2015, the study area was snow covered during the measurements. Snow depth ranged from 8.33cm to 33.60cm and was a few days old. During this time six unmanaged trails were found and mapped, and all six were being solely used by deer. The data collected showed that the widths of the unmanaged trails were substantially narrower than trail widths measured in the fall (Figure 10). The average width of these trails, 33.83cm, is approximately 37% narrower than trails recorded in the fall. The average length of the trail segments was recorded to be longer in the winter than in the fall (Figure 11).

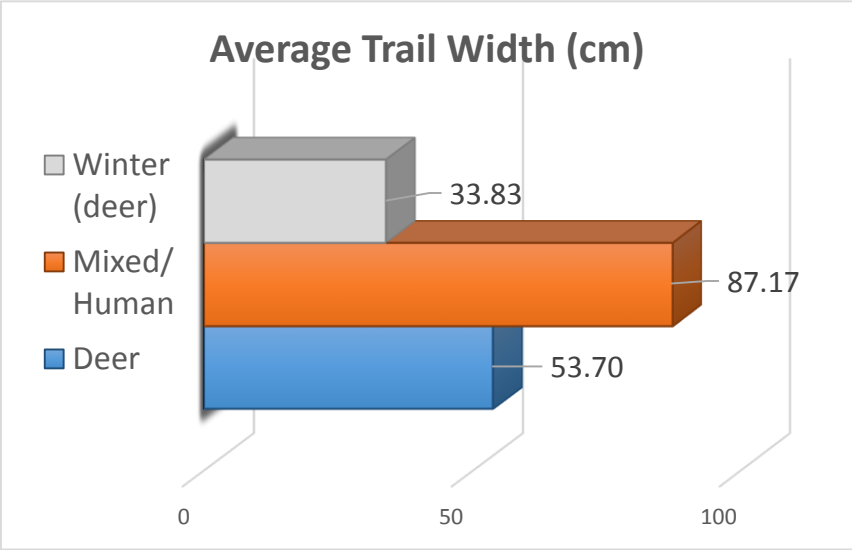

Figure 10. Width of unmanaged trails in fall and winter.

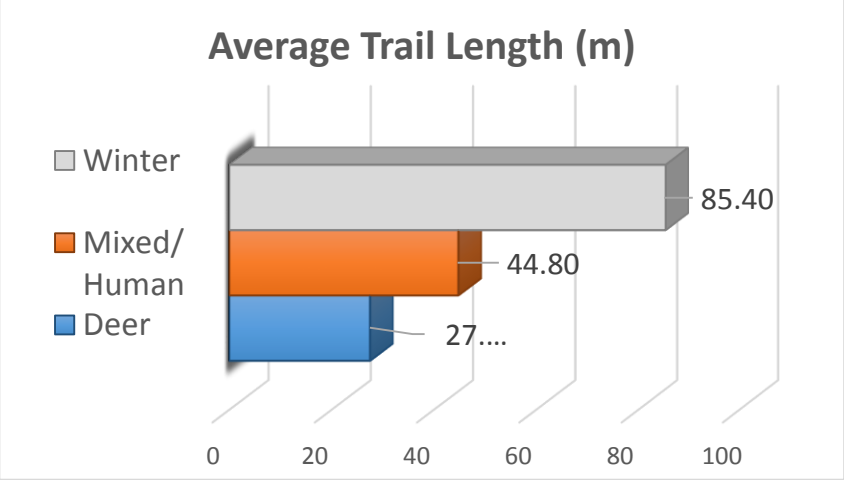

Figure 11. Average length of unmanaged trails in the fall and winter.

During the winter visit, a variety of deer evidence was found with twelve signs in total (Figure 12). An individual deer track was mapped along with two high-track-density areas. Three clusters of deer droppings and a bedding area were also mapped. Other signs of deer evidence included three individual deer beds (Figure 13) and two deer scrapes, where the deer were looking for food beneath the snow. Of these twelve signs that were mapped, only one of the high-track-density areas was located in the open dune study area. The rest of the signs were located within the wooded study area.

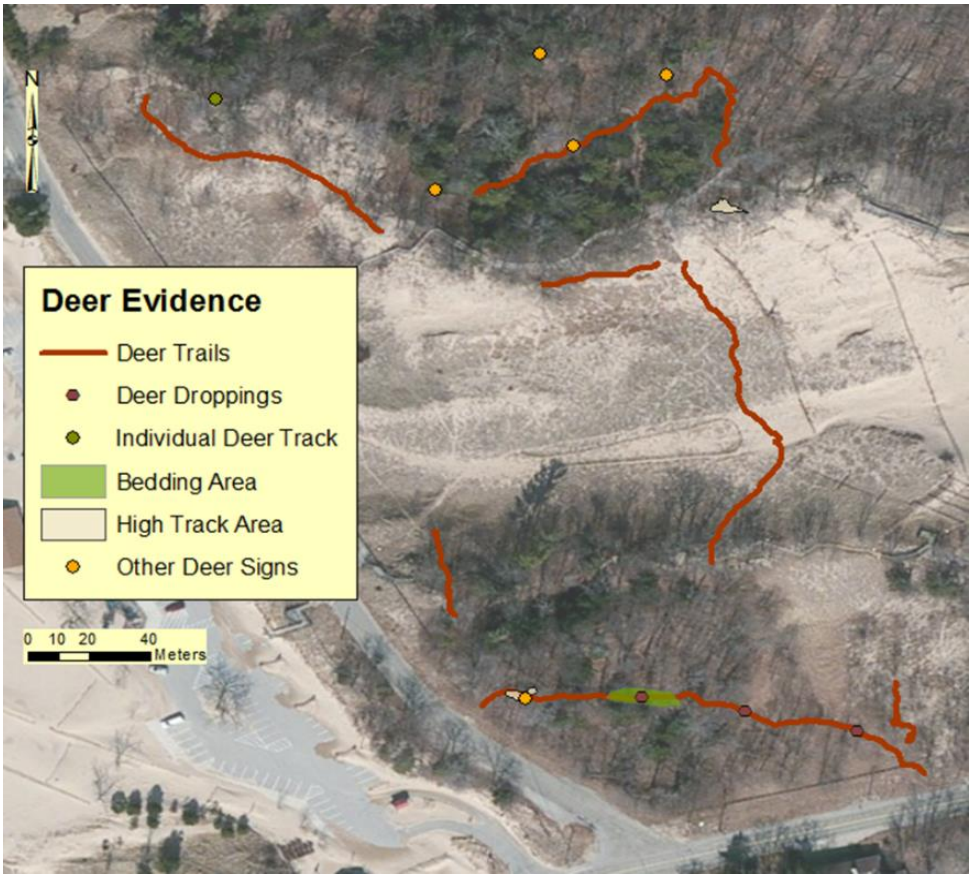

Figure 12. Map of unmanaged trails and deer evidence collected in the winter.

Figure 13. Deer bed found in the wooded study area.

Discussion

The biggest impact of the deer appear to be on vegetation, rather than the topography of the dune. The deer trails that were found were not very deeply eroded and had little noticeable impact on the dune surface itself. The most noticeable aspect of a trail was the lack of vegetation, typically beach grass, where the deer were walking (Figure 14). Damage to the vegetation was most likely the result of trampling from repeated passages of deer.

Figure 14. Deer trail through the open dune area

As deer do not seem to be having a significant impact on the topography of the dune, the current white-tailed deer population does not appear to have a large enough impact to destabilize the North Beach dune. The current deer trails are inconspicuous on the dune and do not create large areas of bare sand that could have a destabilizing effect. Instead, the trails are narrow and typically have vegetation alongside to act as a stabilizer, as can be seen in Figure 14. The impacts to the environment would increase if park visitors began to frequently use the deer trails, as our data demonstrated that mixed-use trails have a greater impact on the dune. However, only nineteen percent of the trails that were documented showed signs of human use, indicating that management efforts are having some success in keeping visitors off the dune.

Our data indicates that deer do not seem to spend as much time on the open area of the dune compared to the wooded areas. In the fall there were a few trails moving north and south over the dune facilitating movement across the open dune area, but there were more trails found in the wooded area. Over half of the deer evidence mapped was found in the wooded study areas. Bedding areas and scrapes, key signs of deer activity, were found in the wooded areas during both seasons of data gathering. The higher amount of deer activity in the wooded study areas was accentuated in the winter. Of the twelve points of deer evidence that were mapped in the winter, only one point was found in the open dune area, and the other eleven were in wooded areas.

A difference in the location of the fall and winter data could be caused by several factors. We were not able to locate many trails in wooded areas during the fall as they were obscured by leaf cover. Some of the deer evidence in the wooded area during the fall could have been missed. Both deer evidence and trails were easier to find, identify, and map in the winter because of the snow cover in the study area. As a result, research and data collection could be done faster and

more efficiently, and a more complete set of trails and data was able to be mapped. Another factor could be that the wooded areas provide more shelter for deer in the winter months than the open dune area, as well as more foraging opportunities. A promising direction for further research would be to determine what factors might be affecting deer movement and location around the dune.

This study identifies a number of interesting patterns that should be the focus of future research. A future study could be expanded to include all of North Beach dune and surrounding wooded areas to investigate whether these patterns apply in a larger area. Further studies could also explore what factors affect deer movement across the dune, such as food sources or certain types of vegetation cover that deer prefer.

Conclusions

During this study in North Ottawa Dunes County Park, we were able to map and measure a variety of deer evidence and unmanaged trails. We can conclude that deer appear to be the primary users of unmanaged trails around North Beach dune. Management efforts by the park appear to be having some success as there was very little evidence of humans on the unmanaged trails on the bottom half of the dune. We also found that deer trails have less of an impact on the dune than mixed-use trails. Deer trails appear to be narrower and shorter, or less distinct on the dune, and have less impact to nearby vegetation compared to unmanaged trails that are also used by humans. And finally, the current white-tailed deer population does not appear to have a large enough impact to destabilize the dune. As long as the deer trails are not encouraging visitors to leave the boardwalk, the trails do not appear to be having a significant impact on the dune surface.

Acknowledgements

We would like to acknowledge Ottawa County Parks and Recreation Commission and Calvin College for allowing us to use their parks and facilities to conduct our research. This project was funded with help from the Michigan Space Grant and the Department of Geology, Geography, and Environmental Studies at Calvin College. Finally, we would like to thank and acknowledge Dr. Deanna van Dijk for her continued mentorship and support during the research process.

Works Cited

Adams, K., and M. Ross (2015). “Whitetail Report 2015.” Quality Deer Management Association.

Andersen, U. V. (1994). “Resistance of Danish coastal vegetation types to human trampling.” *Biological Conservation* 71: 223-230.

Ashkannejhad, S., and T. R. Horton (2006). "Ectomycorrhizal ecology under primary succession on coastal sand dunes: Interactions involving *Pinus contorta*, suilloid fungi and deer." *New Phytologist* 169 (2): 345-354.

Bowles, J.M., and M.A. Maun (1982). “A study of the effects of trampling on the vegetation of Lake Huron sand dunes at Pinery Provincial Park.” *Biological Conservation* 24: 273-283.

Burden, R.F., and P.F. Randerson (1972). “Quantitative studies of the effects of human trampling on vegetation as an aid to the management of semi-natural areas.” *Journal of Applied Ecology* 9 (2): 439-457.

Chandler, G. (2012a). “Ottawa County park to allow deer hunters with firearms this fall.” The Grand Rapids Press, August 30, 2012.

Chandler, G. (2012b). “16 deer taken in first hunt at North Ottawa Dunes Park in Spring Lake.” The Grand Rapids Press, December 17, 2012.

D'Ulisse, A., and M.A. Maun (1996). "Population ecology of *Cirsium pitcheri* on Lake Huron sand dunes: II. Survivorship of plants." *Canadian Journal of Botany* 74: 1701-707.

Gedge, K. E. and M. A. Maun (1994). “Compensatory response of two dune annuals to simulated browsing and fruit predation.” *Journal of Vegetation Science* 5 (1): 99-108.

Hylgaard, T. (1980). “Recovery of plant communities on coastal sand dunes disturbed by human trampling.” *Biological Conservation* 19: 15-25.

Hylgaard, T., and M. J. Liddle (1981). “The effect of human trampling on a sand dune ecosystem dominated by *Empetrum nigrum*.” *The Journal of Applied Ecology* 18 (2): 559-569.

Inouye, R. S., T. D. Allison and N. C. Johnson (1994). “Old field succession on a Minnesota sand plain: Effects of deer and other factors on invasion by trees.” *Bulletin of the Torrey Botanical Club* 121 (3): 266-276.

Jamieson, K., and D. van Dijk (2004). “A study of the active parabolic dune in North Beach Park, Ottawa County, Michigan.” Grand Rapids (MI): Department of Geology, Geography and Environmental Studies, Calvin College. Unpublished report: 41 p.

Liu, C., L. Grevengoed, M. Haugh, M. Koopman, I. Peterson and L. Walters (2014). “An investigation of the relationship between deer and trails in North Ottawa Dunes.” Grand Rapids (MI): Department of Geology, Geography and Environmental Studies, Calvin College. FYRES: Dunes Research Report #12: 20 p.

McNeil, S. G., and J. H. Cushman (2005). “Indirect effects of deer herbivory on local nitrogen availability in a coastal dune ecosystem.” *Oikos* 110: 124-132.

Ottawa County Parks & Recreation (2015). "Ottawa County Parks & Recreation – North Ottawa Dunes." MiOttawa.org. 2015. Accessed April 17, 2015.

Parkin, A., C. Hilbrands, J. Hulst, E. Stranzenbach and S. Vannette (2012). "Analysis of management efforts at North Beach Park dune, Michigan." Grand Rapids (MI): Department of Geology, Geography, and Environmental Studies, Calvin College. FYRES: Dunes Research Report #2: 14 p.

Philips, T., and M.A. Maun (1996). "Population ecology of *Cirsium pitcheri* on Lake Huron sand dunes I. Impact of white-tailed deer." *Canadian Journal of Botany*, 74: 1439-1444.

Santoro, R., T. Jucker, I. Prisco, M. Carboni, C. Battista and A. T. R. Acosta (2012). "Effects of trampling limitation on coastal dune plant communities." *Environmental Management* 49: 534-542.