

# First-Year Research in Earth Sciences: Dunes



## **Effectiveness of Management Techniques Employed at Mt. Pisgah**

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## **ABSTRACT**

Although many Great Lakes coastal dunes possess some level of management, few studies examine whether or not the techniques employed are successful. This project evaluates the effectiveness of management techniques implemented on a highly popular dune on Lake Michigan. Mt. Pisgah is a large parabolic dune in Holland, Michigan that local residents suspected was being degraded by overuse, prompting the application of management techniques such as planted vegetation, sand fences, stairs, and viewing platforms. This study's methods included using sand traps and erosion pins to measure sand transport, mapping management techniques and human impacts, taking comparison pictures, and distributing a questionnaire on visitors' perceptions of management. Despite the remnant of Hurricane Sandy occurring during the study, little sand movement was measured. Mapping and comparison pictures showed that planted vegetation has significantly decreased the amount of bare sand. The presence of litter and a network of unmanaged trails indicate that people are still going places they are not allowed. Nonetheless, questionnaire results showed a positive public reaction to dune management and a willingness to cooperate with guidelines posted on the dune. In general, the management techniques have lowered the possibility of unwanted erosion, increased control over access to the dune, and preserved many natural habitats and features. However, there is room for improvement in the control of litter and unmanaged trails.

## INTRODUCTION

Coastal dunes are dynamic environments, shifting in response to sediment, wind, flora, and fauna. Humans are naturally drawn to undeveloped areas, and the combination of sublime beauty and natural diversity found in dunes makes them especially popular. However, the overuse of dunes can diminish their recreational potential and threaten the viability of local ecosystems, prompting more intensive management (Carlson and Godfrey 1989). In the Great Lakes, Mt. Pisgah in Holland, Michigan is an example of a coastal dune that was shown to be changed by human activities and had management techniques implemented to try to mitigate those changes (van Dijk and Vink 2005). This study investigates whether the management techniques implemented at Mt. Pisgah have been effective at mitigating existing human impacts and whether they will be able to prevent future impacts.

The objectives of this study are:

- To map and assess the presence and quality of implemented dune management techniques,
- To measure dune activity and stabilization on the dune,
- To compare measured dune activity with dune activity in 2005 (as reported by van Dijk and Vink 2005), and
- To investigate visitor perception of dune management in Mt. Pisgah.

## STUDY AREA

Our study was conducted on Mt. Pisgah, a large parabolic dune in Holland, Michigan (Figure 1). Popular Holland State Park campgrounds border the dune to the east and Ottawa Beach cottages border the dune to the west. The Ottawa Beach neighborhood is bordered by Lake Michigan beachfront owned by Holland State Park. Mt. Pisgah itself is a part of land managed by Ottawa County Parks and Recreation Commission (OCPRC), land which includes a series of wooded trails directly north of the dune.

Holland State Park is one of the busiest parks in Michigan, receiving over 1.5 million visitors per year (Powers 2007). Because of the dune's proximity to the park and its location between the campground and the beach, Mt. Pisgah was frequently visited or passed through. In 2005, the OCPRC commissioned a study to investigate local claims that visitor activities were lowering the dune crest (van Dijk and Vink 2005). The study found that trampling caused a



Figure 1 – Location of Mt. Pisgah (circled in red) relative to its surroundings of the Ottawa Beach historic neighborhood (outlined in green) and Holland State Park campgrounds and beachfront (outlined in yellow).

widening of the blowout, a ramp at an unnatural angle down the slipface along a popular path, and a distinctive notch at the crest five meters lower than the surrounding crest (van Dijk and Vink 2005). Results from their visitor questionnaire also indicated that non-local visitors did not see the dune as having problems (van Dijk and Vink 2005).

As recommended by the 2005 study and outlined in their Master Plan (OCPRC 2004), OCPRC implemented a number of management techniques in an attempt to mitigate human-induced changes to the dune. These include structures to control use, such as stairs which are elevated over the slipface ramp, viewing platforms (also known as overlooks or overlook decks), and a boardwalk. Signs were installed to inform visitors and guide their use. Dune grass was planted in strategic locations in conjunction with fences. Altogether management worked to incorporate the dune area into surrounding land uses, for example connecting the boardwalk to the trails to the north and building a trailhead kiosk at the road where campers would walk toward the dune with clear directions that the dune path does not access the beach.

## BACKGROUND

Dune management has different goals depending on circumstances, but in general the aim is to maintain a dune in its current state or control the speed at which it changes. Accomplishing this goal requires knowledge of both natural dune processes and human activities that affect

dunes. Humans can cause changes to dunes in small scale activities such as trampling (Andersen 1995; Santoro *et al.* 2012) and off road-vehicles (Hosier and Eaton 1980) or large scale modifications such as resource extraction, and development (Defeo *et al.* 2009). In environments where the carrying capacity has been exceeded, management efforts may be required to mitigate negative impacts (Carlson and Godfrey 1989). This is the case at Mt. Pisgah; however, few studies focus on the evaluating such efforts.

Managers have a variety of methods available to them. Structures to control use, such as stairs or viewing platforms, prevent degradation on vulnerable areas and have the added benefit of making the dune easier to climb and view (Brooks 2001). Signs create awareness and concern for the dune and the restoration process (NSW Dept. of Land and Water Conservation 2001). Planted vegetation stabilizes the dune by capturing windblown sand and preventing sand from becoming windblown. Planting vegetation is most effective when done in conjunction with sand fences, which create deposits of windblown sediment and thereby allow the planted dune grass to become established and spread (Nordstrom 2000).

International studies that focus on dunes that are being managed or restored give little attention to single, intensively managed dunes like Mt. Pisgah. Despite an understanding of the importance of monitoring (Nordstrom 2008), little work has been published. Landi, Ricceri, and Angiolini (2012) examined the recovery of vegetation on dunes undergoing restoration. Santoro *et al.* (2012) found that sand fences are able to produce positive impacts on dune vegetation after only 1-2 years. In a different vein, Lin and Liou (2013) monitored the success of engineered dune reconstruction. At the scale of long stretches of coastline, a vulnerability index has been developed (Martinez *et al.* 2006) which is mostly applied to help determine allocation of management efforts.

Studies on Great Lake coastal dune restoration are limited. Amsterberg Jr. (1973) and Reinking and Gephart (1978) examined the effect that planting vegetation has on stabilizing dunes. Van Dijk and Vink's (2005) study is the most thorough for Great Lakes management, although its timing did not permit evaluation of the management efforts.

## METHODS

In October and November 2012, the presence and quality of dune management techniques in place at Mt. Pisgah were mapped by handheld GPS units. Mapped management techniques were recently planted dune grass, sand fences, stairs and boardwalk, viewing platforms, informative signs (large displays along the intended visitor paths), warning signs (smaller signs located off the intended path), the entrance kiosk, and the pavement trail to dune. The mapping of sand fences included rating the quality of each fence and marking any locations where the fence was “trampled,” meaning knocked over onto the sand, or broken in some way, such as snapped or missing wooden frames. Other mapped human impacts were unmanaged trails and litter, which was mapped with an attribute for density of either “scarce,” “moderate,” or “common.” Stairs and boardwalk as well as viewing platforms were also given attributes of quality based on sturdiness, durability of construction, and visual aesthetics. The collected data was compiled in GIS and made into maps.

Dune activity in the form of sediment movement was measured in several ways. GPS units were used to map unmanaged trails and the area of the bare sand slipface. Nine erosion pins were placed on the dune in areas where erosion or deposition were suspected, such as blowouts or dune grass (Figure 2). Two semi-permanent fixtures in the dune were also used to measure changes in the height of sand. One was a wooden pole holding a sign and one was part of a sand fence. The pins were placed on October 25 and measured weekly for two weeks using a folding ruler. We analyzed the data to determine patterns and rates of surface change.

Comparison of dune activity in 2012 with 2005 was carried out by photo comparison because erosion pins were not part of the 2005 study. On November 8, pictures were taken replicating perspectives of pictures taken in 2005 of a) the lower blowout viewed from the crest, b) the unusually angled ramp viewed from the base of the slipface, c) the notch in the dune crest viewed from the lower windward slope, d) the middle of the blowout viewed from the south, and e) the notch in the dune crest viewed from the upper slipface.

To understand visitor perceptions of dune management in Mt. Pisgah, a questionnaire (Appendix A) was distributed to visitors who came during the time of our data collection. Each week a group member was stationed with questionnaires at the main viewing platform, located in the notch in the crest. Dune visitors were asked to fill out the questionnaire which contained questions about activities on the dune, number and time of visits, knowledge of dunes, and

perceptions of dune management techniques. Visitor compliance to guidelines was also gauged separately by analyzing mapped human impacts such as litter, broken and trampled fences, and unmanaged trails.

Questionnaire responses were compared to results of questionnaires given to dune visitors in 2005. Sections that were repeated in 2012 included questions on activities visitors participated in while on Mt. Pisgah and what visitors considered annoyances on the dune. Results from 2012 were graphed next to results from 2005 and compared.

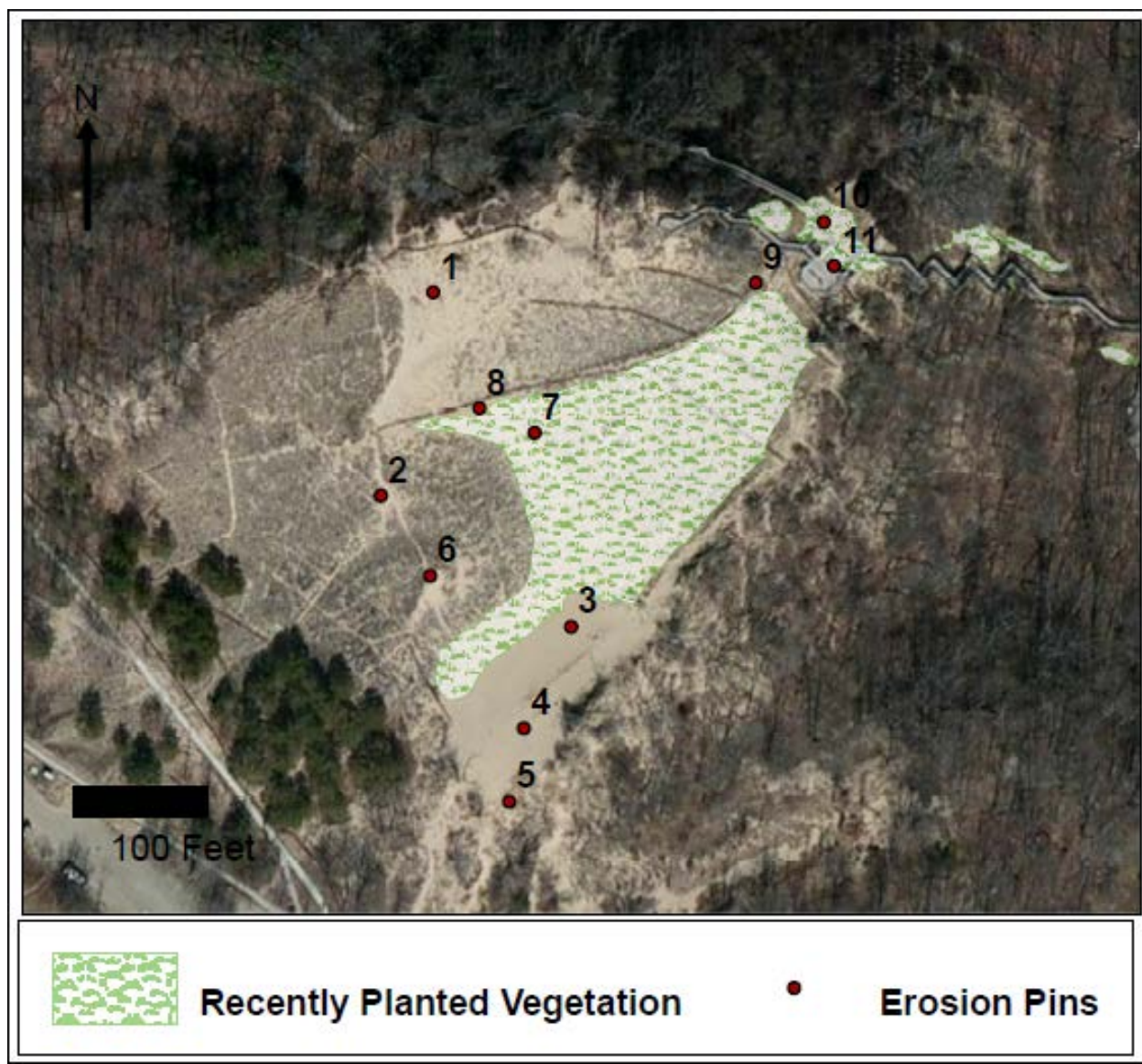


Figure 2 – Erosion pin locations on Mt. Pisgah.

## RESULTS

### *Management Techniques*

In 2012, Mt. Pisgah holds a variety of management strategies from trails to signs, fences, and planted vegetation (Figure 3). The trailhead kiosk adjacent to Ottawa Beach Road and Holland State Park campgrounds marks the entrance to a walkway which winds around residential properties and Holland State Park before leading to the dune stairs. Stairs go up the dune's slipface with three viewing platforms on the stairs before connecting to the largest viewing platform. Additional stairs go up higher to a smaller outlook. A boardwalk connects the largest viewing platform to trails. Six informational signs are located at the kiosk, before the stairs, on the largest outlook, and in front of the windward base of the dune. Twelve warning signs were mapped on the dune. Before the stairs, there is an informational sign as well as fencing and a warning sign. The main viewing platform has two informational signs and four warning signs surround the two viewing platforms. There is one long main sand fence bisecting the blowout, from which six sand fences offshoot. Fences are also clustered near the windward base of the dune and around the north arm. Recently planted areas of *Ammophila breviligulata* (American beach grass) are located on the blowout and the slipface of the dune. There are six

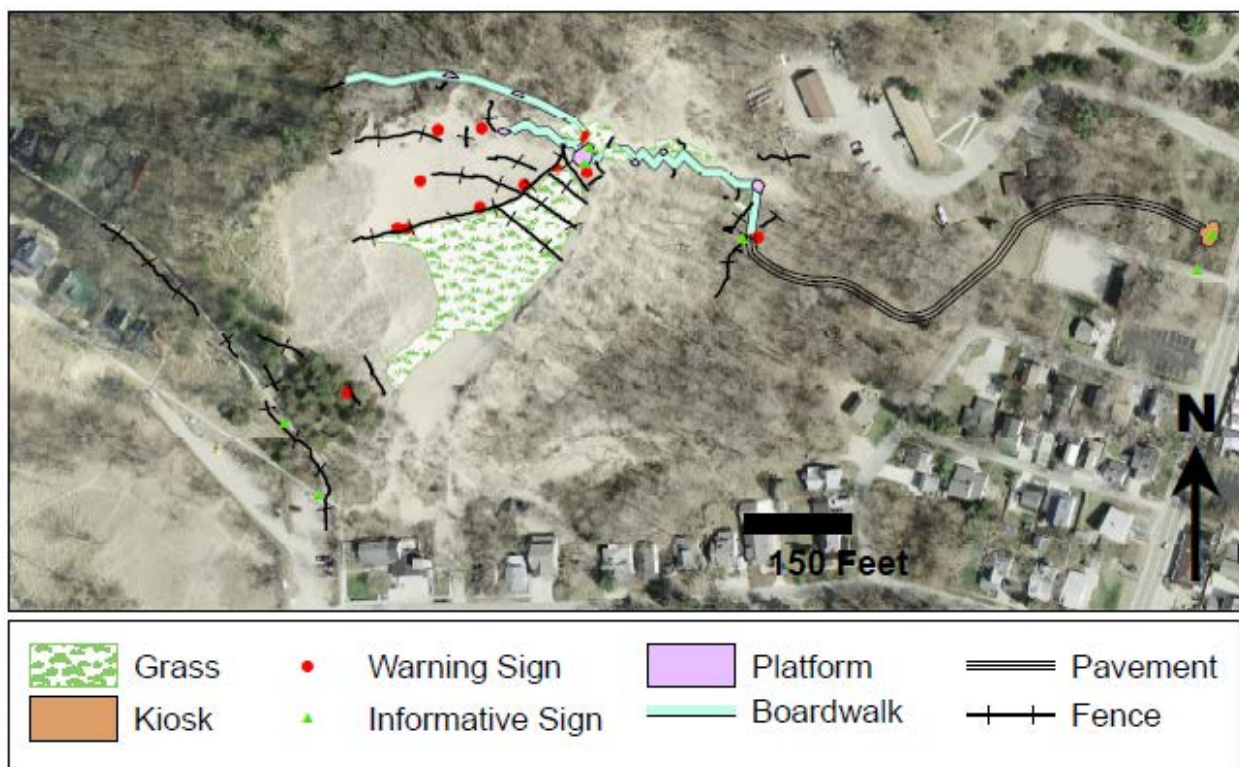


Figure 3 – Management techniques installed on Mt. Pisgah.



warning signs in the blowout and one near the windward base of the dune where there are also two informational signs.

The map of human impacts (Figure 4) shows a network of unmanaged trails on Mt. Pisgah. Mapped trails had a net length of 2,014 meters and are located throughout the dune, although the largest clusters are around the north slip face and the north and west portions of the blowout. Not all unmanaged trails were mapped because of study time constraints. Five trampled fences were mapped and fifteen broken fences. Litter was documented at 56 locations on the dune, with three locations assessed as litter being common, 15 as moderate, and 38 as scarce.

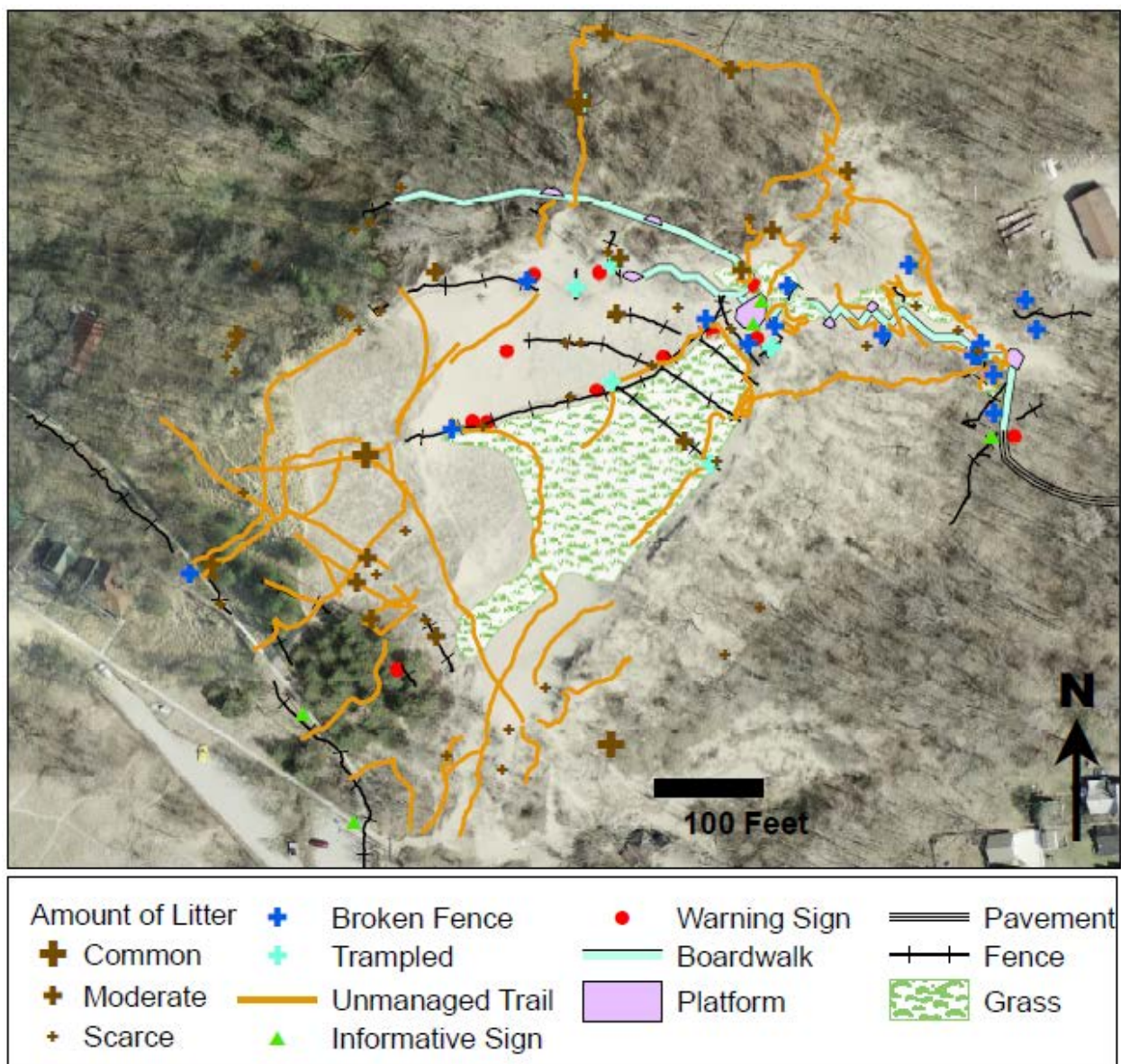


Figure 4 – Human impacts and management techniques on Mt. Pisgah

### *Dune Activity*

Amounts of surface change measured at erosion pins are small (Figure 5). All changes in height were less than 30 mm. Between October 25 and November 1 the largest change was 27 mm (deposition) at pin 5. Between November 1 and November 8 the largest change was -18 mm (erosion) at pin 8.

Comparison of 2005 and 2012 photos shows significant visual differences for five locations (Figure 6). Bare sand in the lower blowout has been mostly covered by planted vegetation (Figure 6a). The unusually angled ramp has been covered by elevated stairs with fences and planted vegetation (Figure 6b). The notch in the crest has been covered by the largest viewing platform (Figure 6c). Bare sand in the middle of the blowout has been mostly covered by planted vegetation (Figure 6d). The intersection of the notch and the unusually angled ramp has been covered by the intersection of the stairs and the viewing platform (Figure 6e).

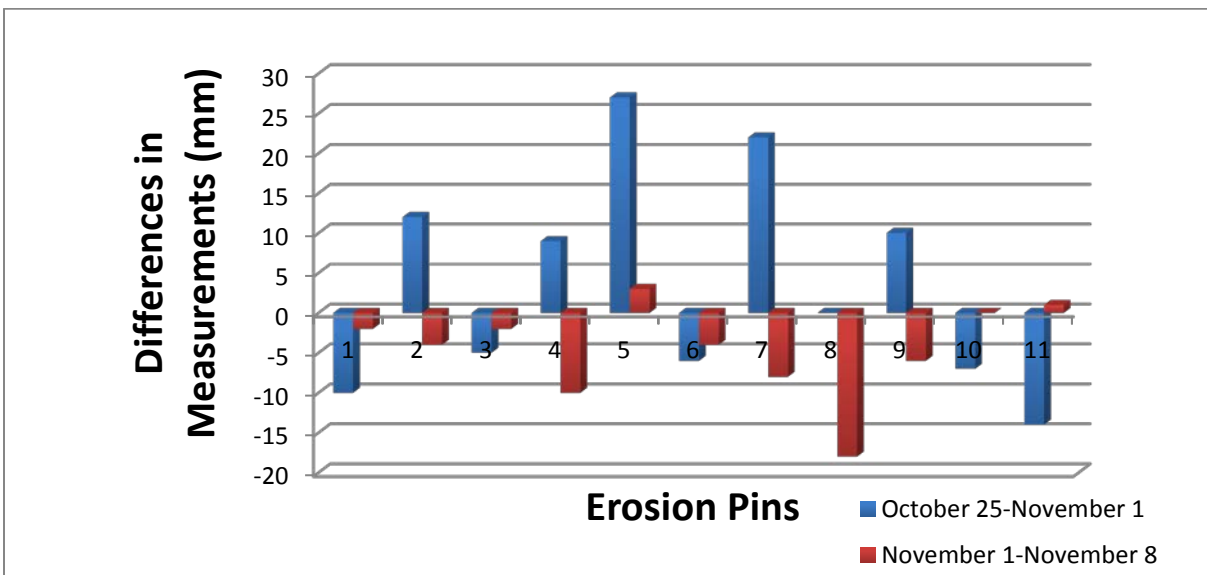


Figure 5 – Results from measurements of height at erosion pins. A positive difference means that there is less sand at the end of the week (erosion) ; a negative height means there is more (deposition).

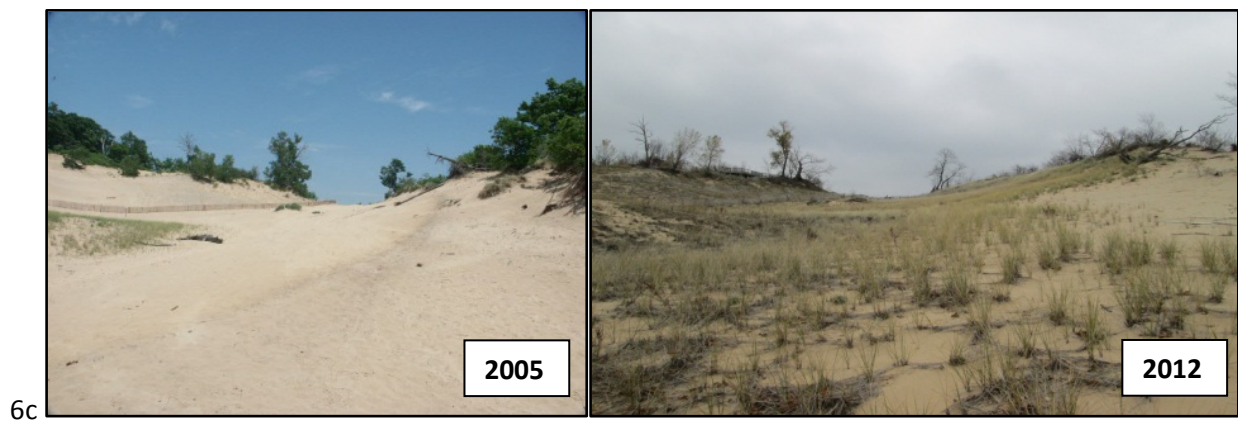
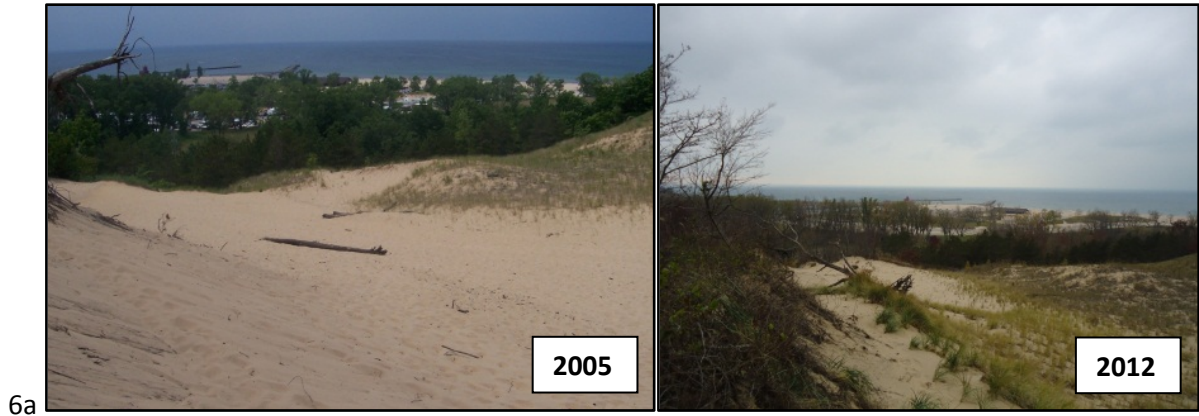


Figure 6 – Comparison pictures between 2005 on the left and 2012 on right. (Continued on next page.)

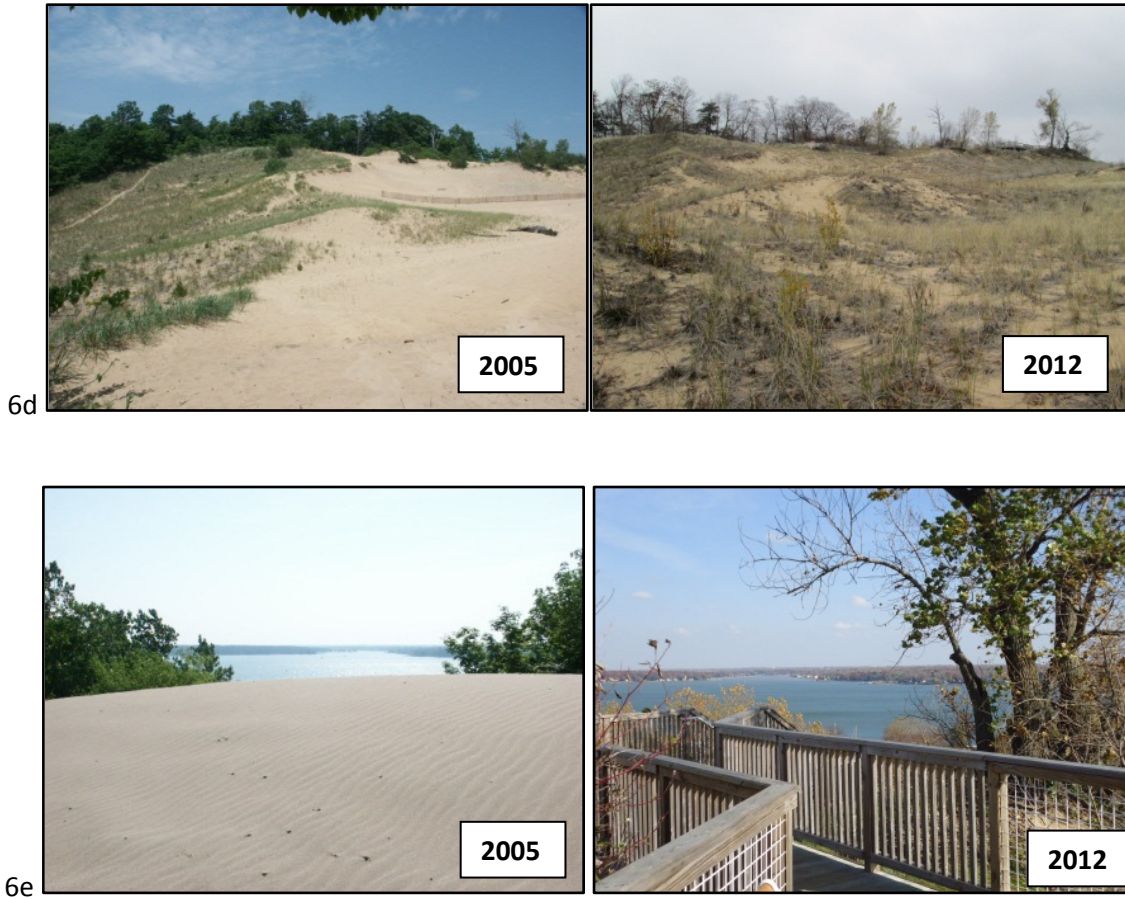


Figure 6 (continued) – Comparison pictures between 2005 on the left and 2012 on right.

*Visitor Perceptions*

During the 7 hours and 52 minutes data was collected, 69 visitors came; 3 groups of visitors had dogs with them. 32 questionnaires were filled out, representing 65 visitors (Appendix B contains questionnaire results). The vast majority of dune visitors who filled out the questionnaire were from Holland (90.8%) and all were from somewhere within an hour of Holland (Figure 7). Visitors were predominantly in the 41-55 years old (26.2%) and 55+ years old (40%) age brackets. Visitors come to Mt. Pisgah during all seasons, but the most come in the

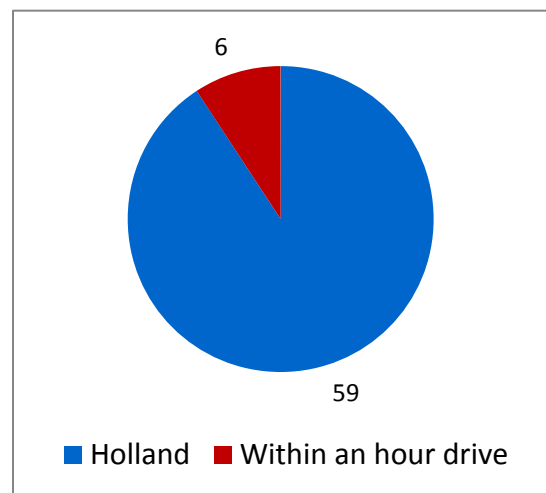


Figure 7 – Origins of dune visitors.

summer (98.4%) and fall (90.3%) (Figure 8). In 2005 the top two activities were “climb the dune” (44.7%) and “run down the dune” (34.2%), but in 2012 these were two of the three least responded activities (down to 10.8% and 1.5% respectively) with the top activity now “climb the stairs” (100%) (Figure 9). The majority of visitors, at a minimum “know a little bit” about dunes (Figure 10). The majority of respondents said they were “in favor” or “strongly in favor” of all management techniques (Figure 11). In 2005, responses to “limiting access to protect dune areas” was 9.4% “strongly opposed” and 21.9% “opposed”; in 2012 9.9% responded either “strongly opposed” or “opposed”. The things the most respondents identified as problems were “litter” and “damage to the dune” (Figure 12). The vast majority responded that the management techniques have been successful, with 41.5% “agree” and 44.6% “strongly agree” (Figure 13).

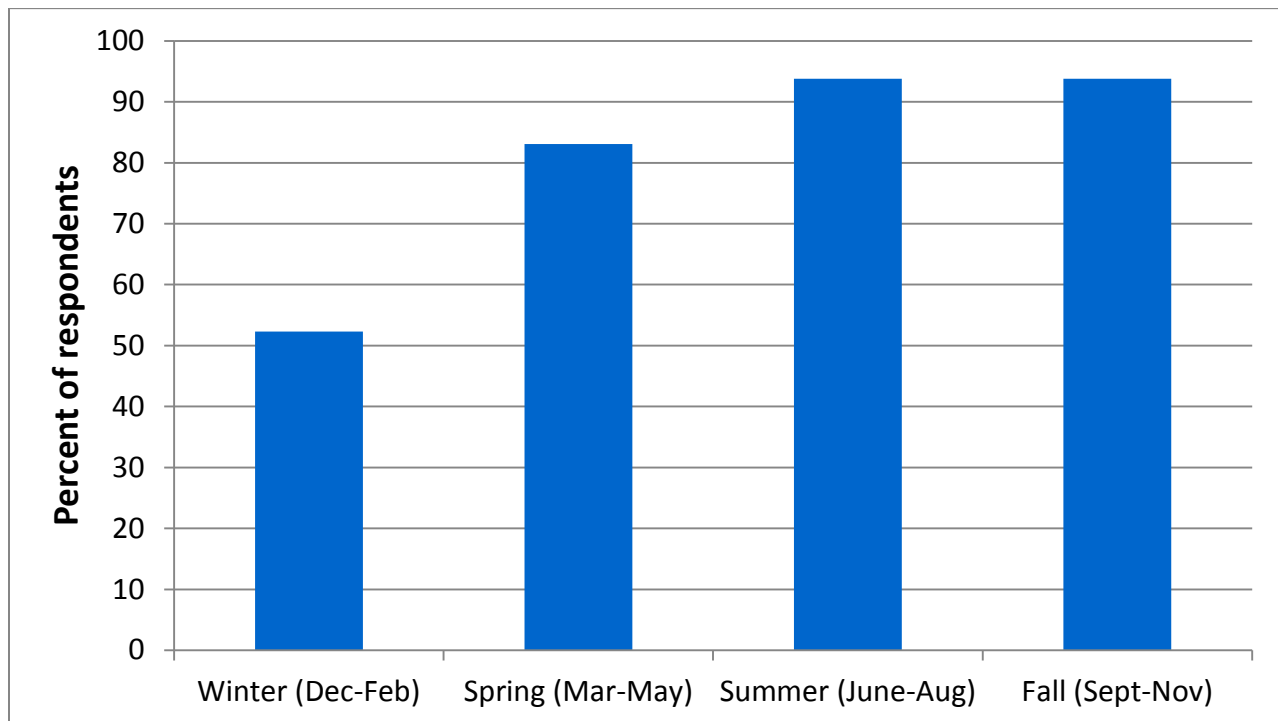


Figure 8 – When respondents visit Mt. Pisgah.

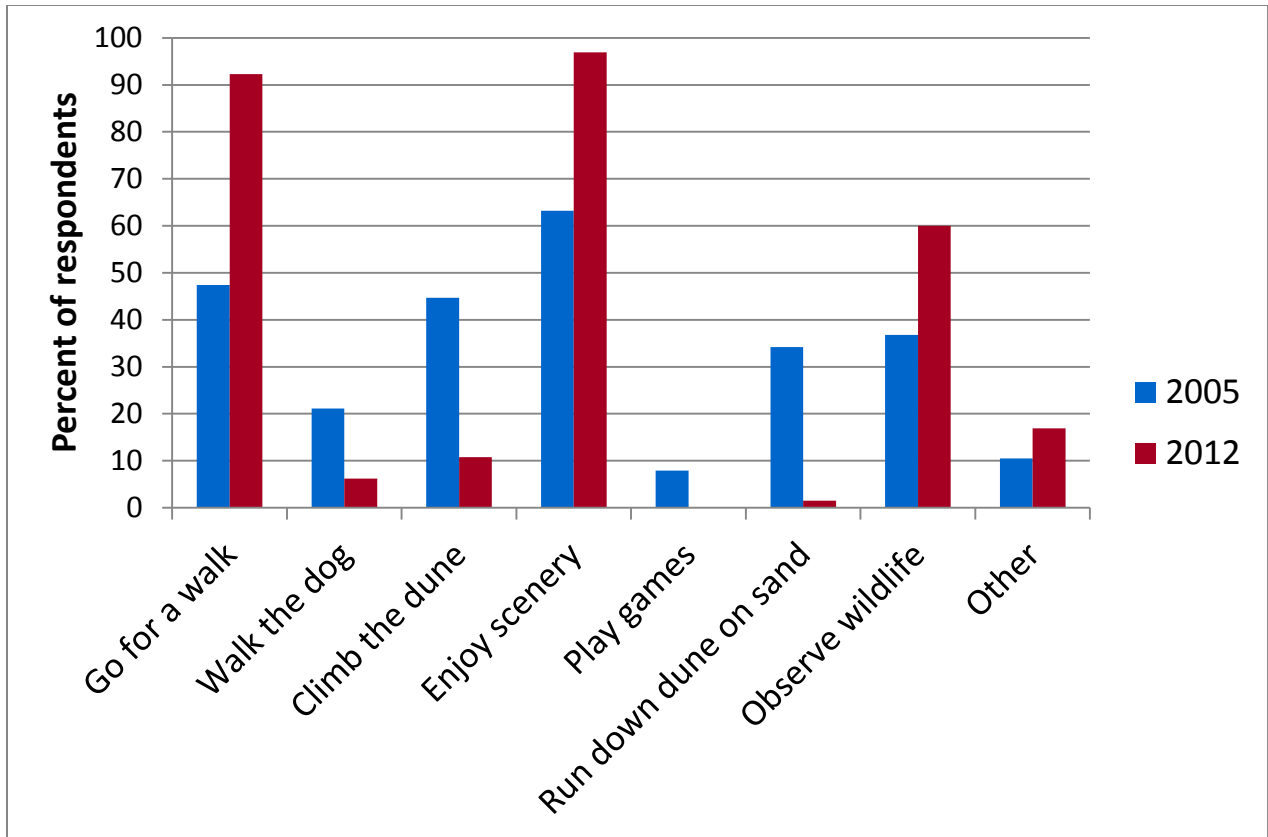


Figure 9 – Activities visitors participate in while on Mt. Pisgah, 2005 and 2012.

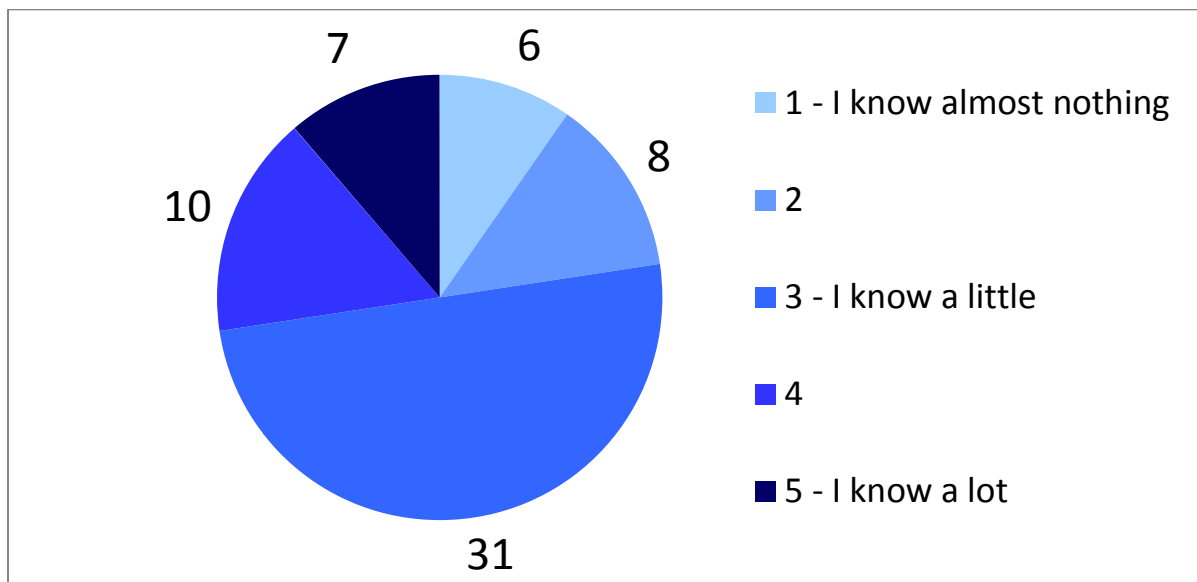


Figure 10 – Visitors' reported level of dune knowledge (in 2012).

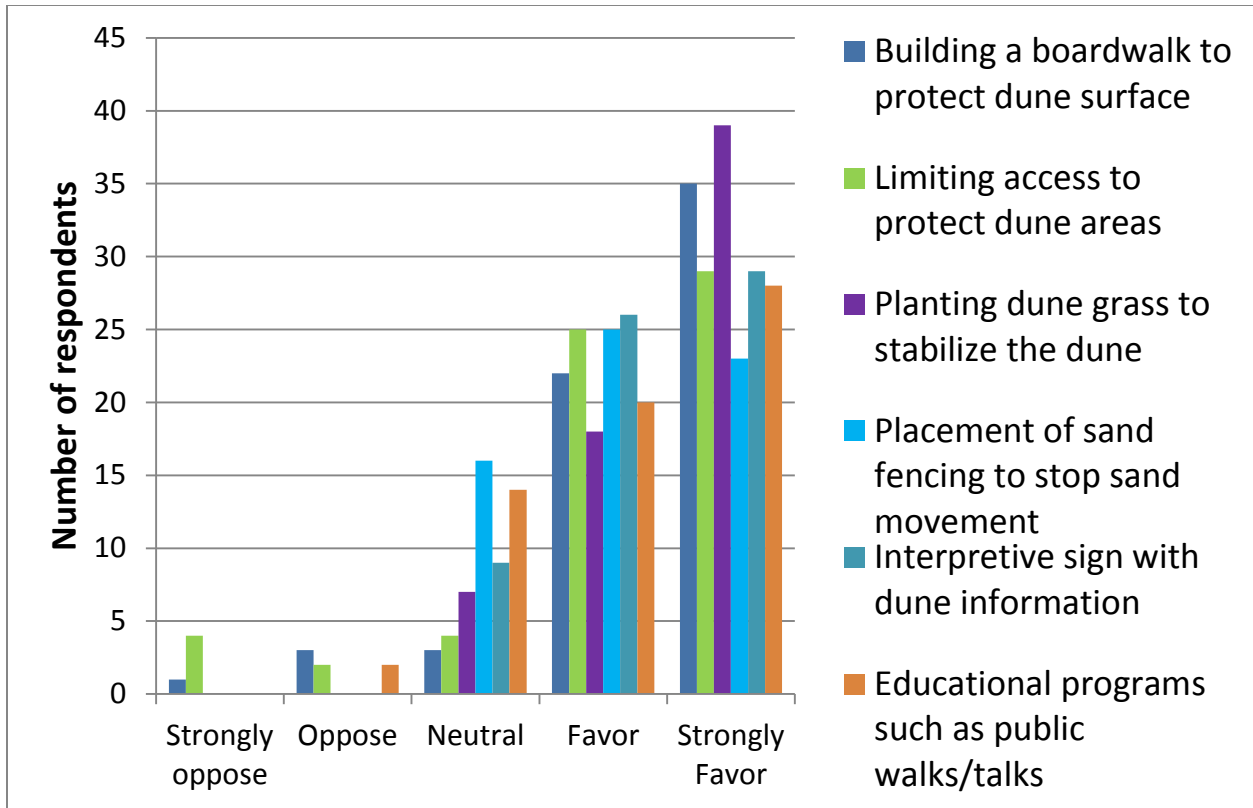


Figure 11 – Respondent opinions of dune management and interpretation activities (in 2012).

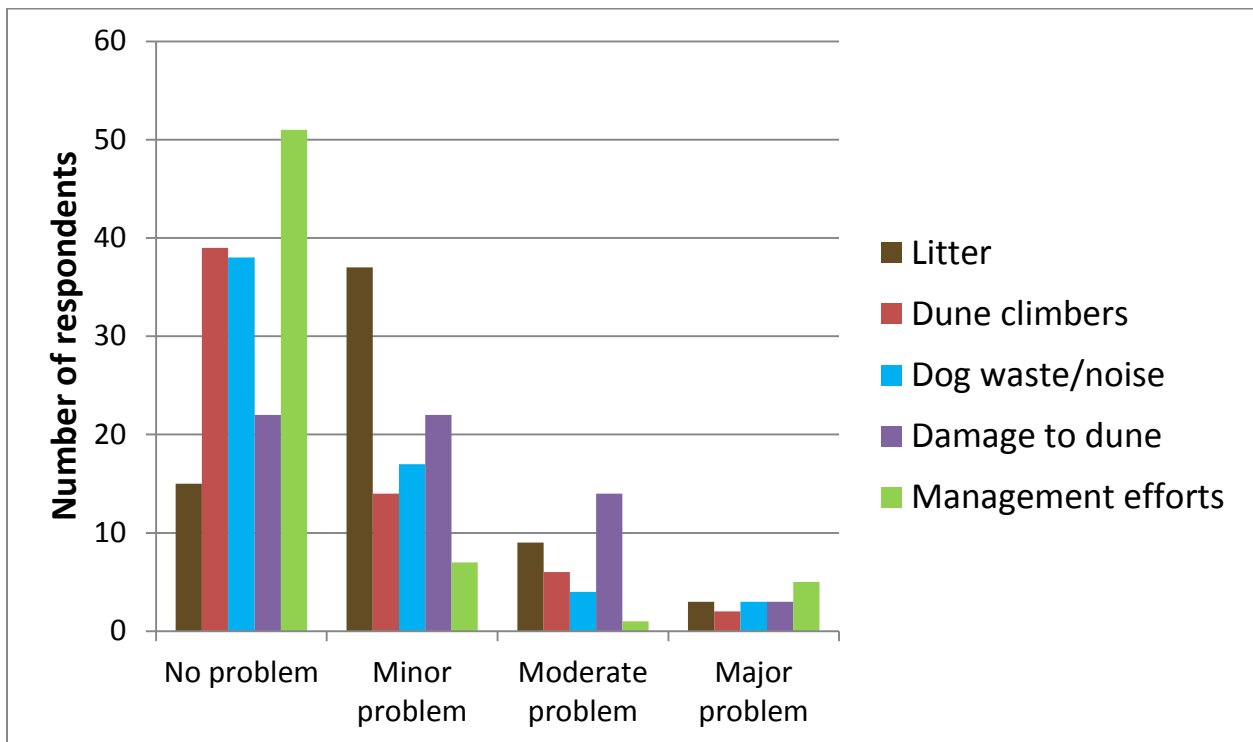


Figure 12 – Responses to “Do you consider the following to be problems/annoyances on the dune?”

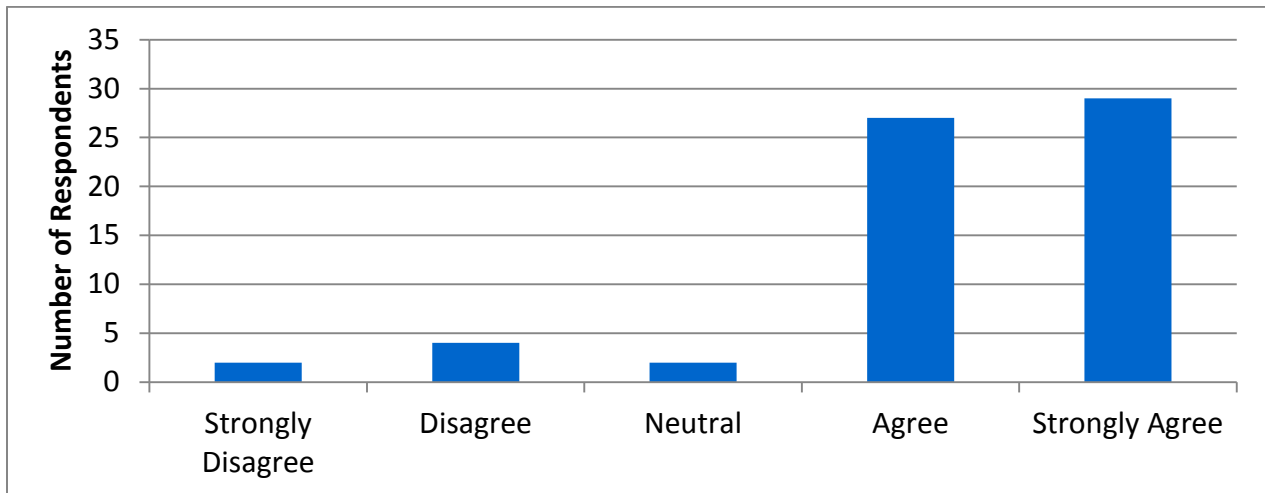


Figure 13 – Reaction to the statement: “The management techniques have been successful”.

## DISCUSSION

The management techniques implemented at Mt. Pisgah address the entire visitor experience as well as natural processes. From the arrival at the kiosk, to the stairs, and up to the viewing platform, there are clear signs guiding and informing visitors about the dune. Even the noncompliant visitor has been prepared for by installing fences and warning signs at spots specifically intended to dissuade potential trespassers. Some fences are also designed to slow windblown sediment to be deposited in surrounding dune grass, which helps the grass grow and keeps sand in the dune system.

Results suggest that not all visitors are complying with management, as indicated by the number and extent of unmanaged trails, litter, trampled fences, and broken fences. Many trails begin near management techniques, pass multiple warning signs, and trample or break fences along the trail, suggesting that management is intentionally ignored. The presence of litter also suggests a level of disrespect for the dune itself. Possible interpretations of these actions include a) youth culture which disregards most directions anyway, (b) local culture, familiar with being able to walk on dunes, feels entitled to continue using off-limit areas, (c) non-local visitors who lack concern for the dune, or (d) visitors who would not normally disregard instructions see trampled fences and unmanaged trails so they do not feel the need to regard instructions either.



While the impacts of noncompliance are significant, the study results show a greater trend toward compliance with management and overall dune recovery.

The low levels of height change recorded in the erosion pins indicate a stabilization of the dune. The results are not merely a product of low winds during the measurement period, as the remnants of Hurricane Sandy were affecting Michigan in the first week of the study. Though sediment is still being redistributed, the amount that is being moved is so low that noticeable changes to the structure of the dune are no longer occurring. Comparison pictures also show that activity on the dune itself has decreased enough to allow the vegetation to take hold and spread. In 2005 the noticeable notch presented a visual target for walking, but in 2012 someone entering from the base of the blowout would see no clear destination for traveling across the dune to the other side (see Figure 6c). These pictures and mapping show the significant increase in vegetation relative to before the management techniques were implemented. The low amounts of measured surface change combine with the comparison pictures to suggest there is less activity and more recovery in 2012 compared to 2005.

Questionnaire responses indicate acceptance and compliance with management techniques. Compared to 2005, there has been a major shift in use for the dune, indicating cooperation. The significant absence of “oppose” or “strongly oppose,” even to limiting access to protect dune areas, indicates visitor acceptance. The fact that litter was the most responded problem/annoyance says again that there is an issue with non-compliance, but it also indicates that the majority of visitors are on the side of management since they identify it as a problem. Respondents identifying “damage to the dune” as the second greatest problem likewise suggests cooperation. Lastly, it is important to note that management has been perceived as a success.

The 2012 questionnaire results suggest directions for further study. As a pilot study, questionnaire administration took place for a limited time during a consistent time of day and week: 3-hour sessions on 3 Thursdays in late fall. The timing likely restricted the numbers and demographics of dune visitors, as well as their source locations. A future comprehensive study with a greater variety of time periods and seasons would be more representative of the population that visits the dune

## **RECOMMENDATIONS**

We recommend a longer term study, replicating more of the 2005 study such as the total station survey, season, and amount of time spent at the dune. This would facilitate a more comprehensive cross section of visitors. It would also permit the replication of polling neighbors to the dune as well as giving time to more deeply investigate unmanaged trails and determine long term strategies to monitor their use and the effectiveness of management.

Preliminary suggestions to improve cooperation by all segments of visitors and reduce the number and extent of unmanaged trails are to:

- Maintain fences more regularly,
- Track unmanaged trails and publicize extent of them,
- Increase educational programs on (interpretive) and away from (schools) the dune, and
- Install cameras to get a better understanding of non-cooperative visitors.

These recommendations might increase compliance with management goals.

## **CONCLUSIONS**

The management techniques installed on Mt. Pisgah have been effective at mitigating and limiting human-caused degradation of the dune, although they have not halted human impacts completely. Low levels of erosion and deposition show increased stability of the dune. Increased areas of dune grass have helped preserve natural habitats and features. Signs and physical restrictions have increased control over access the dune. But numerous unmanaged trails indicate the existence of an uncooperative segment of visitors. Improving upkeep of fences and increasing community outreach would help strengthen levels of cooperation of visitors. A more extensive study is recommended.

## **ACKNOWLEDGEMENTS**

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## Appendix A: 2012 Questionnaire Mt. Pisgah Visitor Questionnaire

**Please answer these questions about the Mt. Pisgah sand dune. You do not need to write your name on this questionnaire, and your answers will not be used to identify you personally. You may choose to answer all, some, or none of the questions. The results from this questionnaire along with other data gathered from the sand dune will be incorporated into a final report to the Ottawa County Parks and Recreation Commission. This report may be obtained upon request. This study is being done by Calvin College students for a course called Geog 181 First-Year Research in Earth Sciences (FYRES) mentored by Joe Arevalo, with faculty advisor Deanna van Dijk.**

**1. Have you visited the dune before?**       Yes       No

**If yes, how often do you visit the dune?** *(Please check the corresponding box.)*

- |   |  |
|---|--|
| <input type="checkbox"/> 1. Once a year           | <input type="checkbox"/> 5. Several times a week |
| <input type="checkbox"/> 2. Several times a year  | <input type="checkbox"/> 6. Every day            |
| <input type="checkbox"/> 3. Once a month          | <input type="checkbox"/> 7. Other _____          |
| <input type="checkbox"/> 4. Several times a month |  |

**2. Where are you from?** *(City, State/Province, Country)* \_\_\_\_\_

**3. Which activities do you participate in when visiting the dune?** *(Please check all that apply.)*

- 1. Go for a walk
- 2. Walk the dog
- 3. Climb the dune (not using the stairs and boardwalk)
- 4. Climb the stairs and use the viewing platform
- 5. Enjoy scenery
- 6. Play games
- 7. Run down the dune (on the sand)
- 8. Observe wildlife
- 9. Read informational signs
- 10. Other *(please specify)* \_\_\_\_\_

**4. During which season(s) do you visit the dune?** *(Please check all that apply.)*

- 1. Winter (Dec-Feb)
- 2. Spring (Mar-May)
- 3. Summer (June-Aug)
- 4. Fall (Sept-Nov)

**5. How much would you say you know about sand dunes?** *(Please circle the corresponding number.)*

I know almost <u>nothing</u>		<u>I know a little bit</u>		<u>I know a lot</u>
1	2	3	4	5

**6. What is your opinion of these dune management and interpretation activities?** *(Please circle the corresponding number.)*

	Strongly oppose	Oppose	Neutral	Favor	Strongly favor
Planting dune grass to stabilize the dune	1	2	3	4	5
Placement of sand fencing to stop sand movement	1	2	3	4	5
Building a boardwalk to protect dune surface	1	2	3	4	5
Limiting access to protect dune areas	1	2	3	4	5
Interpretive signs with dune information	1	2	3	4	5
Educational programs such as public walks/talks	1	2	3	4	5

**7. What is your reaction to the following statement?**

**The management efforts (e.g. fencing, signs, boardwalk) have been successful.**

- Strongly Agree   
  Agree   
  Neutral   
  Disagree   
  Strongly Disagree

**8. Do you consider the following to be problems/annoyances on the dune?**

	Major Problem	Moderate Problem	Minor Problem	No Problem
Litter	1	2	3	4
Noise from vehicles	1	2	3	4
Noise from visitors	1	2	3	4
Dune climbers	1	2	3	4
Dog waste/noise	1	2	3	4
Too crowded	1	2	3	4
Damage to dune	1	2	3	4
Management efforts	1	2	3	4

**9. How many people on the dune are in your group? \_\_\_\_\_ people**

**10. What are the age categories of the people in your group? (Give number of people for each.)**

\_\_\_\_ 0-16      \_\_\_\_ 17-25      \_\_\_\_ 26-40      \_\_\_\_ 41-55      \_\_\_\_ 55 and up

**11. Additional Comments:**

## APPENDIX B: Questionnaire Results

Have you visited the dune before?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	65	100.0	100.0	100.0

How often do you visit the dunes?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Several times a year	30	46.2	46.2	46.2
	Several times a month	12	18.5	18.5	64.6
	Several times a week	16	24.6	24.6	89.2
	Every day	2	3.1	3.1	92.3
	Other	5	7.7	7.7	100.0
	Total	65	100.0	100.0	

Where are you from?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Grand Rapids, MI	4	6.2	6.2	6.2
	Holland, MI	59	90.8	90.8	96.9
	North of Holland, MI	1	1.5	1.5	98.5
	West Olive, MI	1	1.5	1.5	100.0
	Total	65	100.0	100.0	

Which activities do you participate in when visiting the dune? Walk the dog					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	61	93.8	93.8	93.8
	Yes	4	6.2	6.2	100.0
	Total	65	100.0	100.0	



<b>Which activities do you participate in when visiting the dune? Go for a walk</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	7.7	7.7	7.7
	1	60	92.3	92.3	100.0
	Total	65	100.0	100.0	

<b>Which activities do you participate in when visiting the dune? Climb the dune</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	58	89.2	89.2	89.2
	Yes	7	10.8	10.8	100.0
	Total	65	100.0	100.0	

<b>Which activities do you participate in when visiting the dune? Climb the stairs</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	65	100.0	100.0	100.0

<b>Which activities do you participate in when visiting the dune? Enjoy Scenery</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	2	3.1	3.1	3.1
	Yes	63	96.9	96.9	100.0
	Total	65	100.0	100.0	

<b>Which activities do you participate in when visiting the dune? Play games</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	65	100.0	100.0	100.0

<b>Which activities do you participate in when visiting the dune? Run down dune on sand</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	64	98.5	98.5	98.5
	Yes	1	1.5	1.5	100.0
	Total	65	100.0	100.0	

<b>Which activities do you participate in when visiting the dune? Observe wildlife</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	26	40.0	40.0	40.0
	Yes	39	60.0	60.0	100.0
	Total	65	100.0	100.0	

<b>Which activities do you participate in when visiting the dune? Read informational signs</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	32	49.2	49.2	49.2
	Yes	33	50.8	50.8	100.0
	Total	65	100.0	100.0	

<b>Which activities do you participate in when visiting the dune? Other</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	54	83.1	83.1	83.1
	Yes	11	16.9	16.9	100.0
	Total	65	100.0	100.0	

During which season(s) do visit the dune? Winter (Dec-Feb)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	28	43.1	45.2	45.2
	Yes	34	52.3	54.8	100.0
	Total	62	95.4	100.0	
Missing	No Response	3	4.6		
Total		65	100.0		

During which season(s) do visit the dune? Spring (Mar-May)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	8	12.3	12.9	12.9
	Yes	54	83.1	87.1	100.0
	Total	62	95.4	100.0	
Missing	No Response	3	4.6		
Total		65	100.0		

During which season(s) do visit the dune? Summer (June-Aug)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1	1.5	1.6	1.6
	Yes	61	93.8	98.4	100.0
	Total	62	95.4	100.0	
Missing	No Response	3	4.6		
Total		65	100.0		

During which season(s) do visit the dune? Fall (Sept-Nov)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1	1.5	1.6	1.6
	Yes	56	86.2	90.3	91.9
	11	5	7.7	8.1	100.0
	Total	62	95.4	100.0	
Missing	No Response	3	4.6		
Total		65	100.0		

<b>How much would you say you know about sand dunes?</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.0	6	9.2	9.2	9.2
	2.0	8	12.3	12.3	21.5
	2.5	1	1.5	1.5	23.1
	3.0	31	47.7	47.7	70.8
	3.5	2	3.1	3.1	73.8
	4.0	10	15.4	15.4	89.2
	5.0	7	10.8	10.8	100.0
	Total	65	100.0	100.0	

<b>What is your opinion of these dune management and interpretation activities?</b>					
<b>Planting dune grass to stabilize the dune</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	7	10.8	10.9	10.9
	Favor	18	27.7	28.1	39.1
	Strongly favor	39	60.0	60.9	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

<b>What is your opinion of these dune management and interpretation activities?</b>					
<b>Placement of sand fencing to stop sand movement</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	16	24.6	25.0	25.0
	Favor	25	38.5	39.1	64.1
	Strongly favor	23	35.4	35.9	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

What is your opinion of these dune management and interpretation activities?					
Building a boardwalk to protect dune surface					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly oppose	1	1.5	1.6	1.6
	Oppose	3	4.6	4.7	6.3
	Neutral	3	4.6	4.7	10.9
	Favor	22	33.8	34.4	45.3
	Strongly favor	35	53.8	54.7	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

What is your opinion of these dune management and interpretation activities?					
Limiting access to protect dune areas					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly oppose	4	6.2	6.3	6.3
	Oppose	2	3.1	3.1	9.4
	Neutral	4	6.2	6.3	15.6
	Favor	25	38.5	39.1	54.7
	Strongly favor	29	44.6	45.3	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

What is your opinion of these dune management and interpretation activities?					
Interpretive signs with dune information					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	9	13.8	14.1	14.1
	Favor	26	40.0	40.6	54.7
	Strongly favor	29	44.6	45.3	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

<b>What is your opinion of these dune management and interpretation activities? Educational programs such as public walks/talks</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Oppose	2	3.1	3.1	3.1
	Neutral	14	21.5	21.9	25.0
	Favor	20	30.8	31.3	56.3
	Strongly favor	28	43.1	43.8	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

<b>What is your reaction to the following statement? The management efforts (e.g. fencing, signs, boardwalk) have been successful.</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	3.1	3.1	3.1
	Disagree	4	6.2	6.3	9.4
	Neutral	2	3.1	3.1	12.5
	Agree	27	41.5	42.2	54.7
	Strongly Agree	29	44.6	45.3	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Litter</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	15	23.1	23.4	23.4
	Minor problem	37	56.9	57.8	81.3
	Moderate problem	9	13.8	14.1	95.3
	Major problem	3	4.6	4.7	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Noise from vehicles</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	40	61.5	66.7	66.7
	Minor problem	17	26.2	28.3	95.0
	Major problem	3	4.6	5.0	100.0
	Total	60	92.3	100.0	
Missing	No response	5	7.7		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Noise from visitors</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	50	76.9	78.1	78.1
	Minor problem	14	21.5	21.9	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Dune climbers</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	39	60.0	63.9	63.9
	Minor problem	14	21.5	23.0	86.9
	Moderate problem	6	9.2	9.8	96.7
	Major problem	2	3.1	3.3	100.0
	Total	61	93.8	100.0	
Missing	No response	4	6.2		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Dog waste/noise</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	38	58.5	61.3	61.3
	Minor problem	17	26.2	27.4	88.7
	Moderate problem	4	6.2	6.5	95.2
	Major problem	3	4.6	4.8	100.0
	Total	62	95.4	100.0	
Missing	No response	3	4.6		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Too crowded</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	50	76.9	80.6	80.6
	Minor problem	10	15.4	16.1	96.8
	Moderate problem	2	3.1	3.2	100.0
	Total	62	95.4	100.0	
Missing	No response	3	4.6		
Total		65	100.0		

<b>Do you consider the following to be problems/annoyances on the dune? Damage to dune</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	22	33.8	36.1	36.1
	Minor problem	22	33.8	36.1	72.1
	Moderate problem	14	21.5	23.0	95.1
	Major problem	3	4.6	4.9	100.0
	Total	61	93.8	100.0	
Missing	No response	4	6.2		
Total		65	100.0		



Do you consider the following to be problems/annoyances on the dune? Management efforts					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No problem	51	78.5	79.7	79.7
	Minor problem	7	10.8	10.9	90.6
	Minor/Moderate problem	1	1.5	1.6	92.2
	Major problem	5	7.7	7.8	100.0
	Total	64	98.5	100.0	
Missing	No response	1	1.5		
Total		65	100.0		

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-16	1	1.5	1.7	1.7
	17-25	10	15.4	16.9	18.6
	26-40	5	7.7	8.5	27.1
	41-55	17	26.2	28.8	55.9
	55+	26	40.0	44.1	100.0
	Total	59	90.8	100.0	
Missing	No response	6	9.2		
Total		65	100.0		