

# Effect of Pathogens on a Wooded Dune Environment

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## Abstract

Invasive insects and pathogens have long plagued North American forests, resulting in loss of native species and geomorphological change. This study evaluates the effects of these invaders on the wooded dunes of PJ Hoffmaster State Park, Michigan and possible effects this invasion may have on dune stability and ecology. Tree density, composition, and girth were recorded across three visits utilizing point-quarter vegetation transects and large vegetation quadrats paired with wind measurements. American Beeches (*Fagus granifolia*), Red Oaks (*Quercus rubra*), and Sugar Maples (*Acer saccharum*) constituted a majority of tree cover with Hemlocks (*Tsuga Canadensis*) occurring in concentrated groups. Wind speed was inversely correlated with tree density which generally increased with distance from the active dune slopes. There was no evidence of pathogenic infection found during fieldwork, suggesting that no infection has spread throughout the park as far as the coast. Due to the prevalence of Red Oak, oak wilt and its effect on dune stability may be a serious concern in the near future. The groupings of Hemlock may hinder the rapid spread of the woolly adelgid by limiting the contact between individuals.

## Introduction

Due in part to increased globalization and climate change, introductions of non-native forest pests and pathogens are on the rise [1,2]. Each new introduction puts more stress on remaining woodlands. In vulnerable landscapes such as Michigan coastal dunes, the survival of forests depends on understanding the pathogens and their impacts. This study investigated the vulnerability of a wooded dune environment by:

- Determining the composition of trees within the study area,
- Measuring the physical characteristics of the coastal dune forest area, and
- Using the collected data to identify potential pathogenic risk.

## Study Area

The study occurred in P.J. Hoffmaster State Park, Michigan (Fig. 1). The park has had problems with oak wilt and ash borers in the past and is currently struggling with an infestation of woolly adelgids.

Focus was on the southern half of the park comprised of three large parabolic dunes. This area of the park receives fewer visitors and so was a more pristine environment and less likely to have a current outbreak of the various pathogens threatening the park.

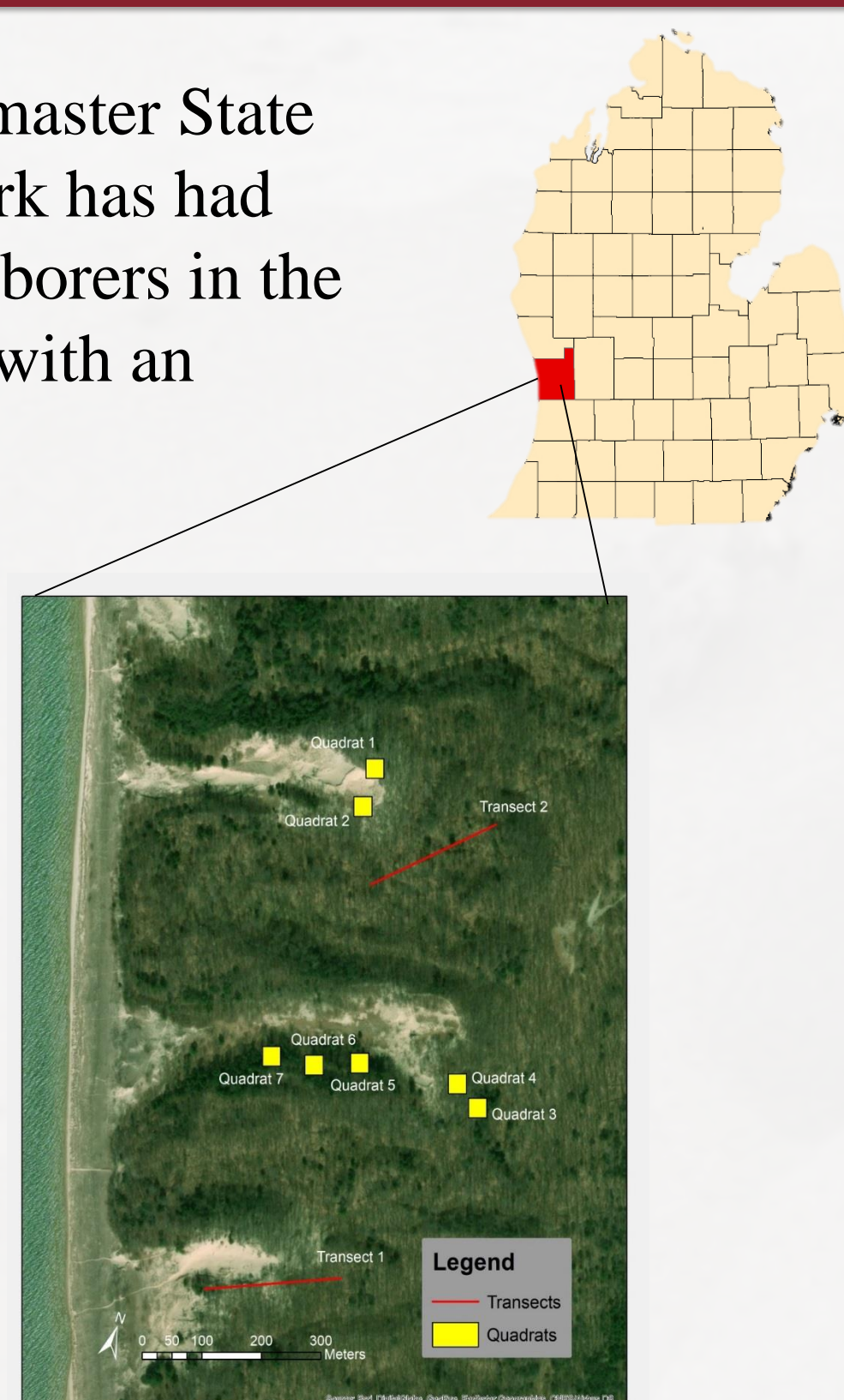


Figure 1: Location of P.J. Hoffmaster State Park in Ottawa County, MI and sampling locations in the park.

## Methods

Forest composition was measured using two sampling methods:

- Two point-quarter transects comprised of 25m segments reaching about 250m in length, and
- Seven large (10m x 10m) quadrats spread across three dunes.

At sampling sites, tree composition and other characteristics were measured (Table 1).

Physical characteristics of the dunes, such as erosion and wind speed, were also measured at each of the sampling sites (Table 1).

Trees were examined for pathogen presence. Risk of future pathogen impacts was assessed based on tree composition and dune environments.

Variable	Method
Tree Density	Counted trees in predetermined areas
Tree Frequency	Identified species within predetermined areas
Tree Diameter	Measured with diameter-at-breast-height tape
Tree Height	Calculated using abney level and measuring tape
Dune Erosion	Visually observed and assigned to a five point rating system
Wind Speed	Measured using handheld anemometers
Species Importance	Calculated for each species by adding relative density, relative dominance, and relative frequency

Table 1: Variables measured in the field and their corresponding methods.

## Results

### Species Characteristics

Red Oak, Sugar Maple, and American Beech dominated in both relative frequency (Fig. 2) and overall importance (Fig. 3). Eastern Hemlocks occurred in a few small groupings and had a low relative frequency.

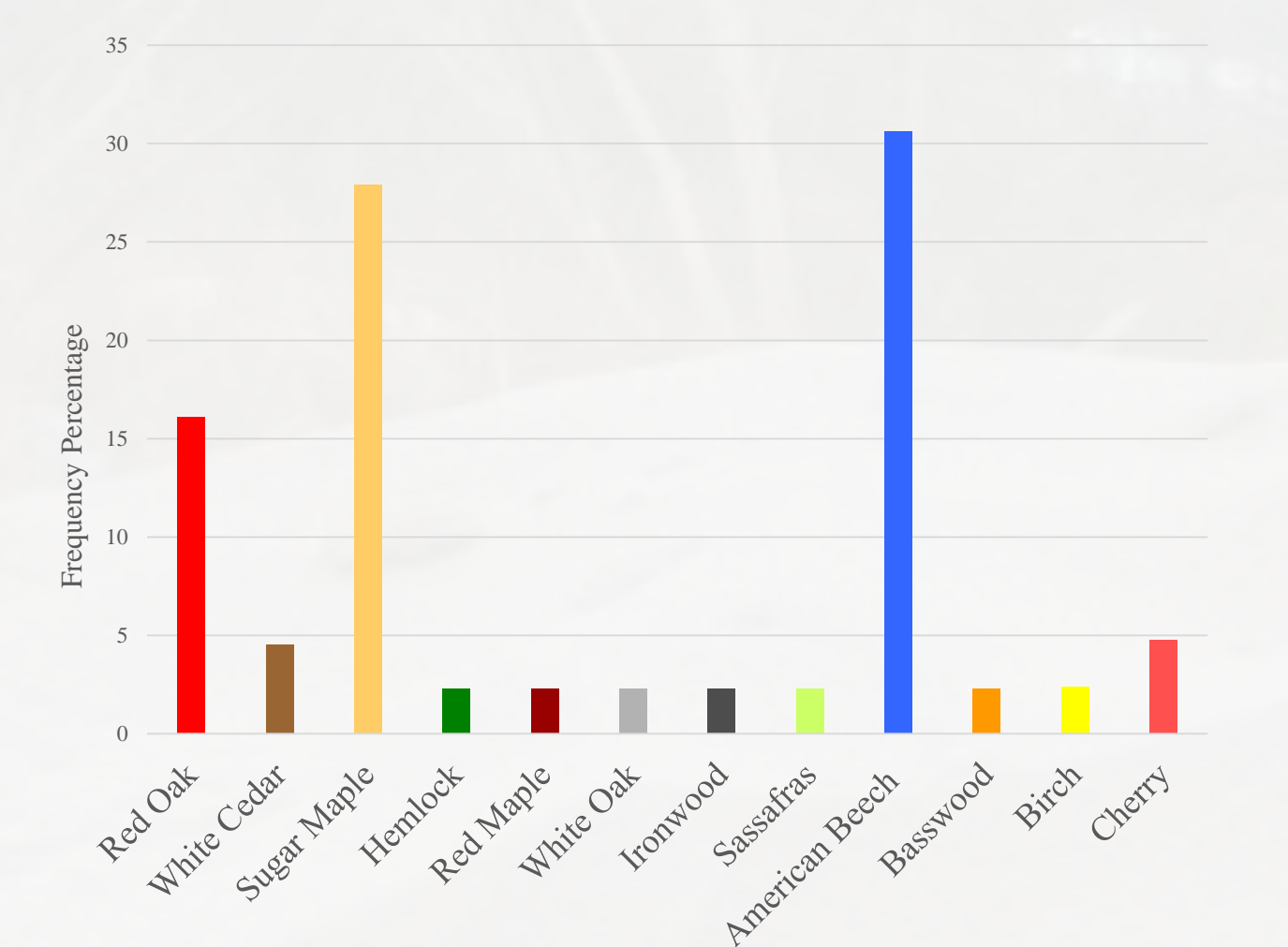


Figure 2: Relative frequency of all encountered species.

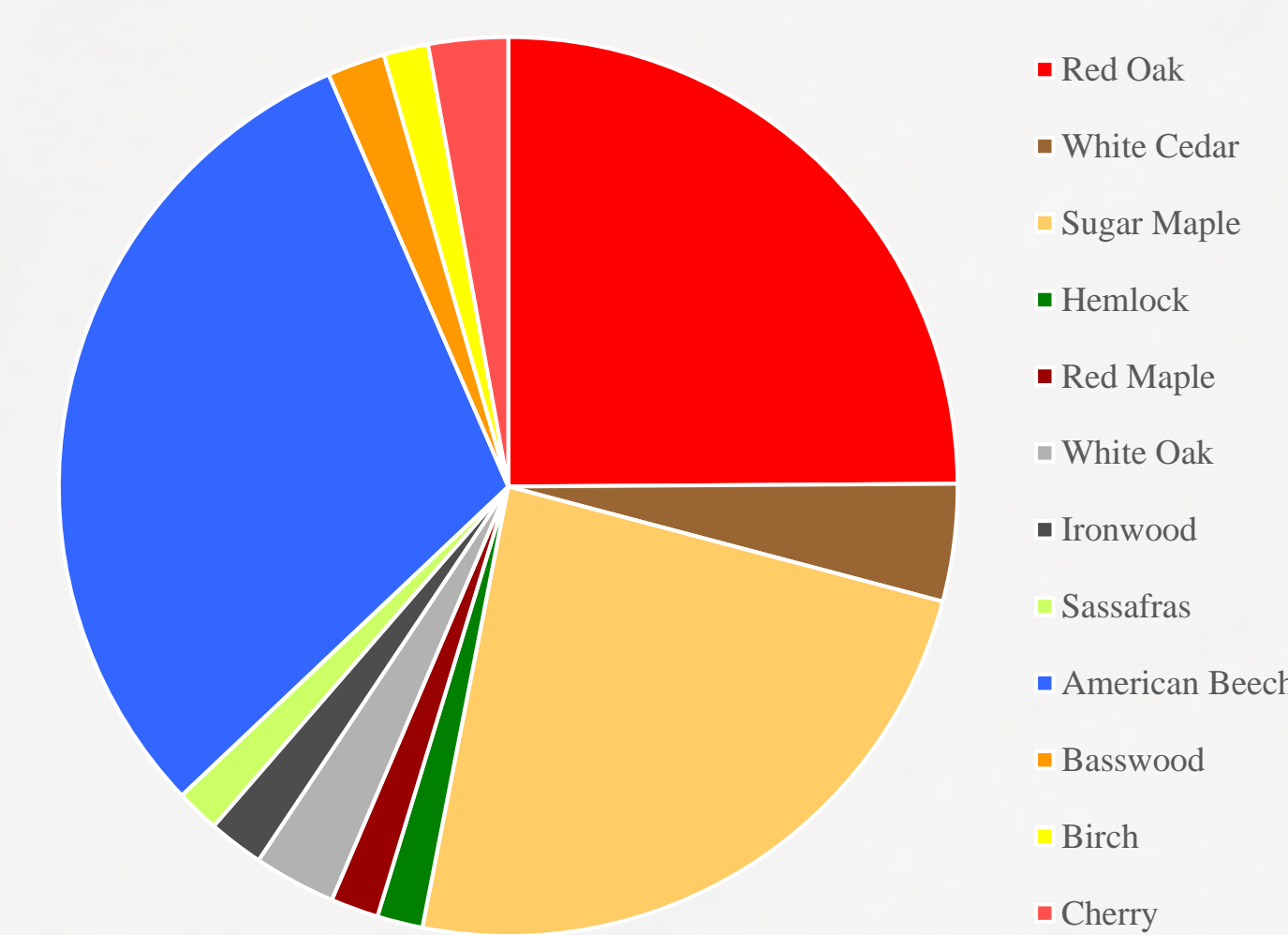


Figure 3: Importance of all encountered species. Importance takes into account frequency, density, and dominance.

### Physical Characteristics of the Coastal Dune Environment

Tree height increased away from the coast with a noticeable dip at the base of the main parabolic dune (Fig. 4).

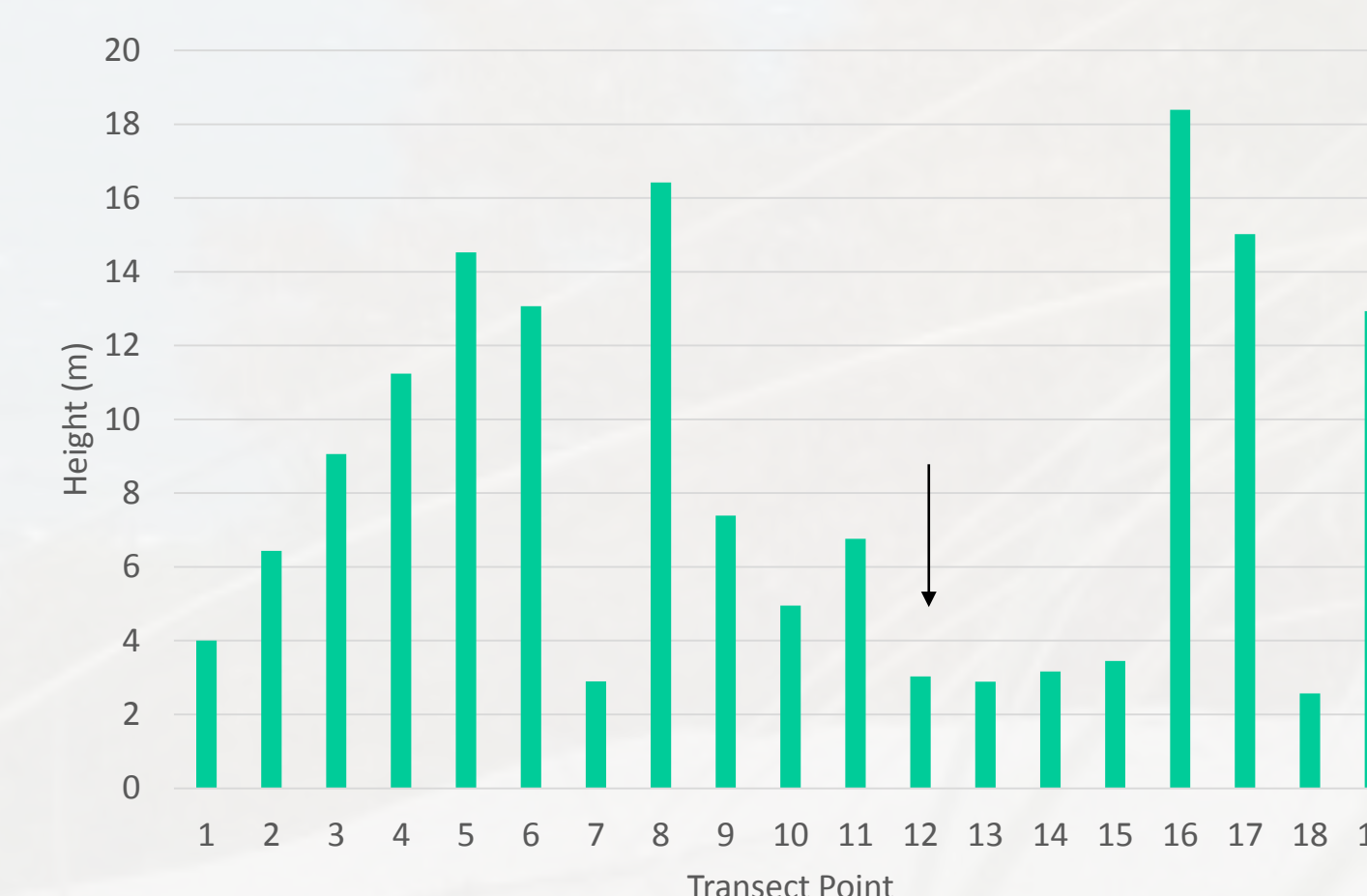


Figure 4: Height of the tallest tree at each point along the transects. Arrow indicates the base of the parabolic dune.

Wind speed typically decreased with increasing tree density (Fig. 5). Evidence of erosion increased with wind speed (Fig. 6).

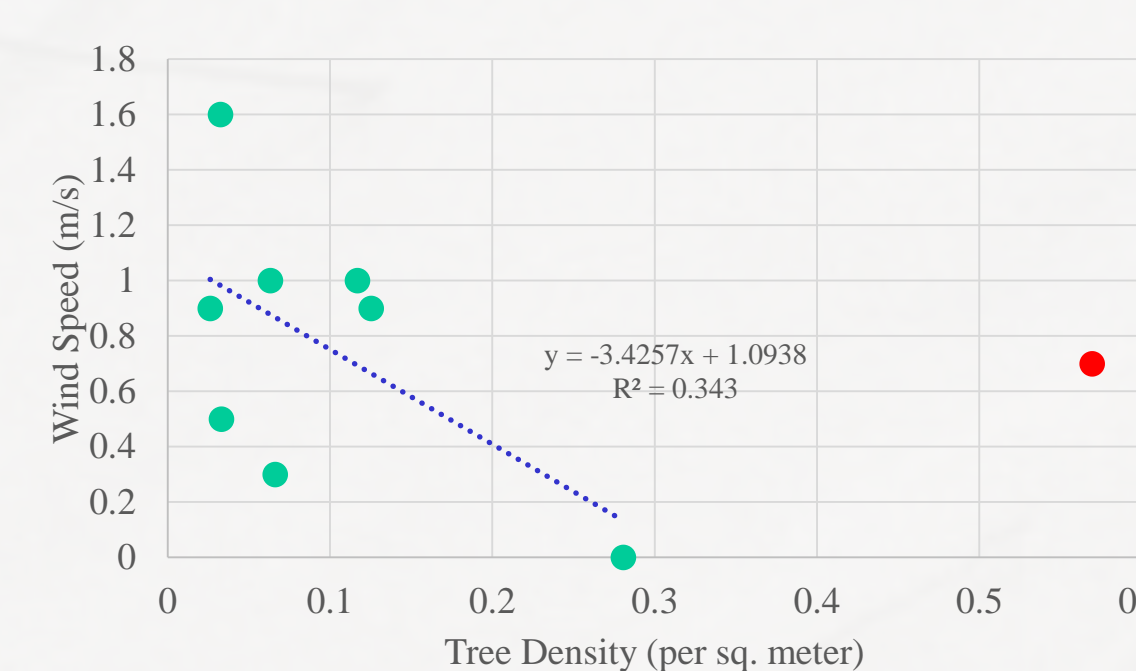


Figure 5: Wind speed against tree density. One outlier (red dot) has been left out of calculations.

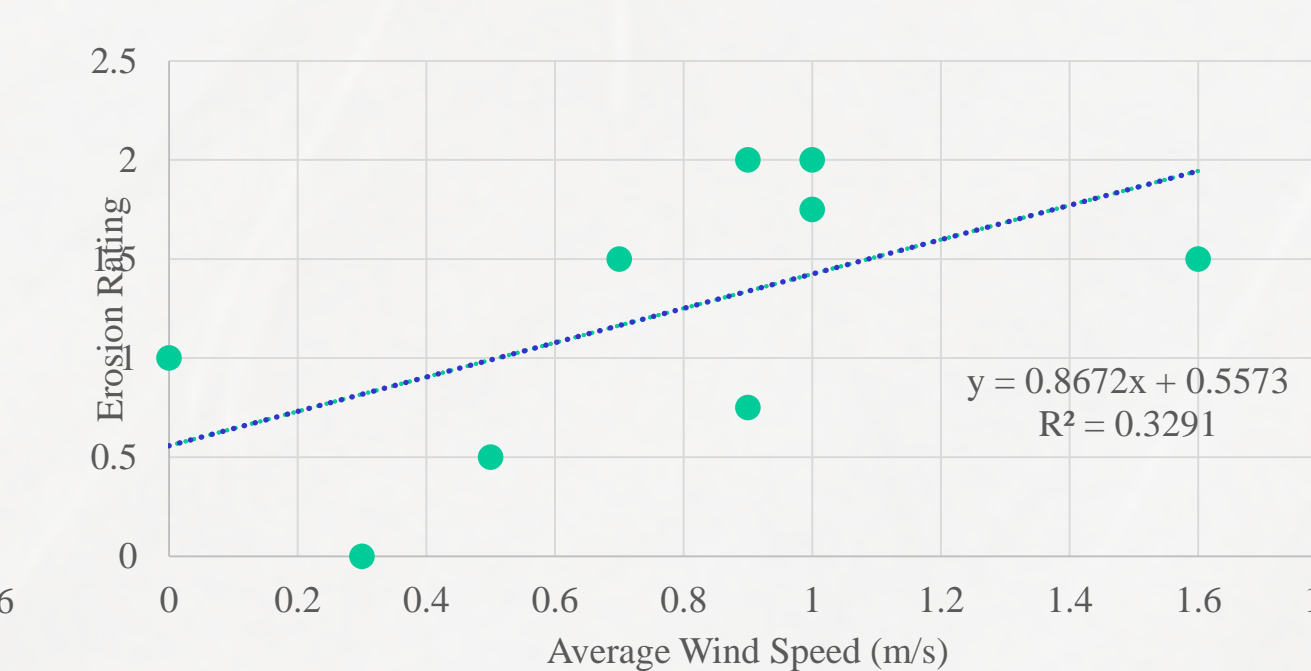


Figure 6: Erosion ratings against the average wind speed at that location.

### Pathogen Presence

No visible signs of major pathogen or parasite were observed. Trees in the area would be at risk if any of the following pathogens were found; oak wilt (oaks), woolly adelgid (hemlocks), or Asian long-horned beetle (maples).

## Discussion

Red Oak, Sugar Maple, and American Beech dominate the landscape due to their tolerance for well drained sandy soils [1]. The dip in tree height at the base of the dune's slipface may be the result of burial or harsher growing conditions (Fig. 7).

The relationships between wind speed, erosion, and tree density suggest that increased erosion may become a concern if large numbers of trees die.

As Maples and Red Oaks are so dominant, an uncontrolled outbreak of Asian long-horned beetles or oak wilt could devastate the tree population, hurting the immediate stability of the dune and its ecosystem [2,3].

The pattern of infrequent hemlocks would be expected to hinder the spread of the woolly adelgid. The park has already seen an accelerated spread of the pathogen perhaps due to the help of unknowing park guests.

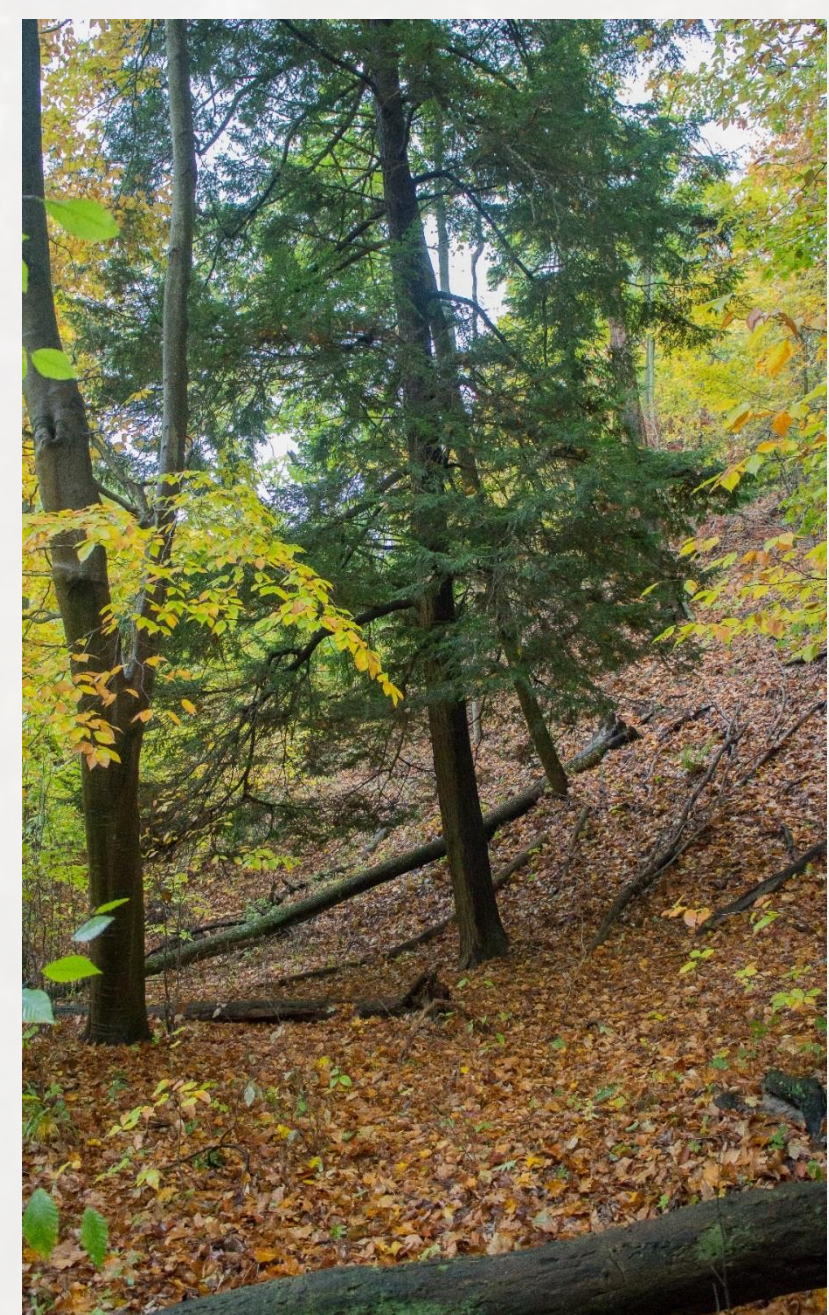


Figure 7: Small grouping of hemlocks located on the lower slipface.

## Conclusions

Red Oak, Beech, and Sugar Maples constitute the majority of trees within the park, with wind speed correlating to both erosional activity and tree density. While no major outbreaks or infestations of pathogens were found in the southern area of the park, watch should be kept for oak wilt and long-horned beetles as their arrival could mean disaster for dune stability and ecology.

## Acknowledgments

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## References

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