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Slope Stability and *Arbutus menziesii*: A Summary of Research in Magnolia Park, Seattle, Washington

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Abstract: Research conducted along the slide-susceptible bluff in Magnolia Park, Seattle, Washington strongly suggests that trees above the crest of the slope contribute significantly to the geotectonic stability of the slope below. The Pacific madrone (*Arbutus menziesii*) is an important component of the tree community along the bluff and is recommended for planting to enhance erosion control wherever it will thrive.

Vegetation is a critical component in maintaining stable slopes and, according to Morgan and Rickson (1995), "...performs a major engineering role in protecting the landscape." Vegetation helps stabilize slopes by several means: by absorbing water via roots and transpiring it back into the atmosphere through leaves; by increasing the penetration of water into the soil and thereby reducing surface erosion; and, by providing a network of roots that increases the physical cohesion of the soil mass, both vertically and horizontally (Coppin and Richards 1990). The most effective vegetation includes a high diversity of plants, of all habit classes (trees, shrubs and herbaceous plants) with different, structurally complementary root systems (Menashe 1993).

Magnolia Park which overlooks Puget Sound just north of downtown Seattle, Washington is an excellent site to study the relationship between vegetation and slope stability. Much of the toe, or base, of the slope has been removed over time for houses along Perkins Lane, and the vegetation at the crest, or top, of the slope is very irregular and heterogeneous due in part to the desire of neighbors across Magnolia Boulevard to preserve their view of the Sound and the Olympic Mountains. The 1995–96 slides along the bluff, while unfortunate for many residents of Perkins Lane, provided us the opportunity to determine how, or if, vegetation at the slope's crest contributes to slope stability. The following account summarizes work done in 1996, reported fully by Parker (1996).

METHODS

In the spring and summer of 1996 we mapped 15 landslides along the bluff, classifying them as major or minor according to their width, with minor slides being less than 15 m (50 ft) wide. We then utilized our maps of the bluff to determine the corresponding street address on Magnolia Boulevard at the crest of the bluff, and then walked the crest to examine the vegetation. We classified the vegetation as lawn, shrub, lawn/shrub and lawn/shrub/tree. We also evaluated the vegetation at 15 randomly chosen sites that did not have slides on the slope below. Finally, we analyzed the data using a chi-square test to quantify the statistical significance of the relationship between vegetation and slope stability. Due to low numbers of sites, we combined both types of landslide and simplified the vegetation classification as trees present versus absent (Parker 1996).

RESULTS AND DISCUSSION

Along Magnolia Bluff, the presence of trees appears to play a major role in the stabilization of the slopes below (Table 15-1). The evident strength of this relationship is particularly striking because one would expect geotectonic heterogeneity along the approximately 1.6 km (1 mi) length of the bluff to be the major determinant of where slides take place; and, therefore, to mask or at least to reduce the appearance of any slope-vegetation connection.

In addition, all 3 severe slides observed occurred below areas where only lawn is maintained at the crest. Causality is difficult to establish for certain because, while lawn serves almost no slope-stabilization function and therefore could have contributed to the slope's instability, the slope's instability, conversely, could prevent the establishment of any crest vegetation beyond grass.

It is clear, nevertheless, that the above results present a compelling argument for the maximization of a diverse tree component of vegetation at and above the crest of any slope, if stability is a desired

Table 15-1. Relationship between occurrence of landslides and presence or absence of trees at the crest of the slope, along Magnolia Bluff, Seattle. Chi-square = 7.03, degrees of freedom = 1 and $p < 0.01$. Data for 1995–96.

Vegetative cover	Slides	No slides
Trees absent	9	2
Trees present	6	13

objective of its management. The results should not be taken to suggest, however, that trees at the crest provide a certain prophylactic with regard to landslides; too many other, nonvegetative, factors are at work as well. Slope vegetation is particularly crucial in urban areas where the great increase in paved, impermeable surfaces has exacerbated surface runoff and flooding even in times of only moderately high rainfall.

The Pacific madrone (*Arbutus menziesii*) is one of several trees in a suite of species valued for slope stabilization (Menashe 1993). As documented elsewhere (Bressette and Hamilton this volume) madrone is sensitive to certain environmental conditions and is particularly impacted by changes in its light and water environments. We recommend, therefore, that healthy trees be preserved, vigorous seedlings allowed to grow and additional trees planted (along with other favored plants; see Menashe 1993 and Parker 1996 for plant lists) in areas presently with little vegetation. We hope further that enough new trees are planted along Magnolia Boulevard to significantly assist the slope, while still allowing sufficient scenic views of Puget Sound for which the Boulevard is renowned.

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