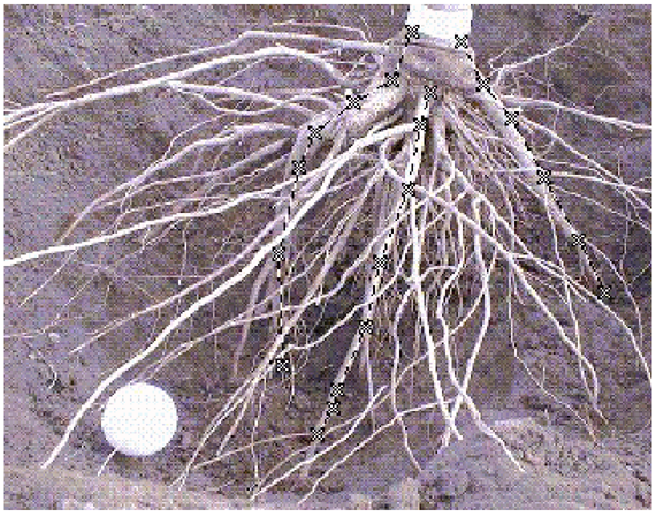


Figure 1. One of four photographs of an exposed root system that had been marked for creation of a 3-D model. White sphere in lowe-left corner is 2 inches (5.1 cm) in diameter.

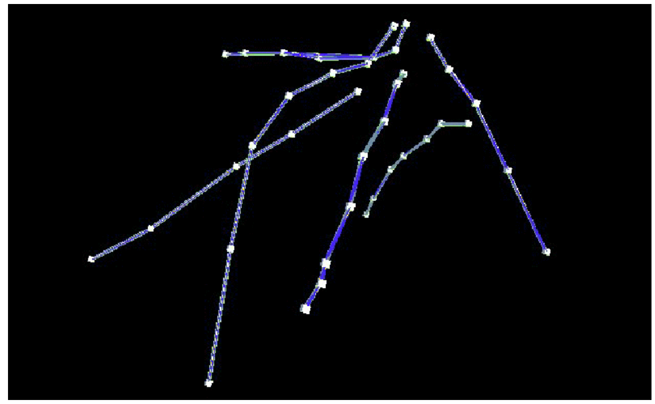


Figure 2. 3-D model showing position and angle of major structural roots for the root system photographed in Figure 1.

Selection and Propagation of Deep-rooted Ornamental Trees for Urban Environments

David W. Burger

Introduction

Ornamental trees in urban environments provide myriad biological, physical, economical and sociological benefits. Trees: 1) provide a habitat for a wide range of animal life, 2) function as a cleansing mechanism for polluted air, 3) shade houses and other structures thus reducing the need for electrically powered air conditioners during the summer and 4) provide an environment in which human beings can connect with nature. However, some trees have root systems that cause damage to sidewalks, curbs and gutters. This damage is the result of planting trees in planting areas that are too small or too narrow and/or the trees inherent tendency to have shallow, horizontally oriented roots. This problem is of major proportions in many cities in California. In a survey of cities in the Bay Area in 1984, 60% of the street trees were estimated to have caused some or severe damage. A more recent survey of sidewalks in San Jose, CA, found the estimated repair cost for tree related damage to be $14.3 million and annual concrete repair costs attributed to tree damage range from $0.18 to $13.65 per tree. It's quite apparent that even a partial solution to this problem would result in substantial savings for city residents and governments.

Materials and Methods

Fifty, seed-propagated liners each of *Fraxinus uhdei, Pistacia chinensis* and *Zelkova serrata* were planted in field plots in Davis in July, 1997. In January, 1999, the root systems of half the trees of each species were exposed using a newly developed supersonic air technique (Gross, personal communication). Each root system was marked (main roots only) and photographed from 3-4 angles (Figure 1). The exposed root systems were then covered with soil immediately after photographing. The photographs were scanned and imported into PhotoModeler Pro 3.0 (Eos Systems, Inc.) computer software for the creation of three-dimensional models (Figure 2). The three-dimensional (3-D) models were constructed from X, Y and Z coordinates derived in PhotoModeler. The X and Y coordinates were used to determine the horizontal distance from the main stem (X in Figures 3 through 8) of any marked point; the Z coordinate for each marked point was used to determine the depth. These two-dimensional (2-D) representations of the 3-D models plotted distance from the main stem versus depth for marked points on all main roots. Linear equations were fitted to these data and the slopes used to compare root systems within each species. Deeper root systems had more negative slopes of the fitted lines. Table 1 is a summary of the root distance and depth data collected from the three tree species.

Pistacia chinensis trees had the most negative average slope (deepest root systems, on average) and also had the highest percentage of trees with slopes

Table 1. Root architecture descriptors

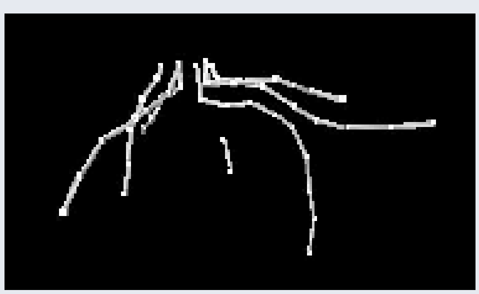
	Fraxinus uhdei	*Pistacia chinensis*	*Zelkova serrata*
Minimum Slope (shallowest root system)	-0.50 Figure 3	-0.63 Figure 5	-0.70 Figure 7
Maximum Slope (deepest root system)	-2.35 Figure 4	-2.95 Figure 6	-2.40 Figure 8
Average Slope “ 1 SD	-1.1" (0.5)	-1.5 “ (0.6)	-1.2 “ (0.5)
Percent of trees with slopes less than -1.0	60	79	53

below -1.0. A slope of -1.0 indicates that, on average, the roots are at a 45E angle or more from the horizontal surface.

Figures 3 through 8 show representatives of each of the three tree species. Those individual trees having the smallest and largest mean vertical angle (least and most negative slopes, respectively) from the soil surface will be selected for further vegetative propagation and subsequent field trial.

Vegetative Propagation of Selected Individuals

Based on the results of the linear regression values, two shallow-rooted and two deep-rooted individuals for each species were selected for vegetative propagation. The selected individuals were: *Fraxinus* 2-8, 2-9, 2-10, 3-13; *Pistacia* 3-7, 3-10, 3-14, 3-15; *Zelkova* 2-2, 2-4, 2-6, 2-9. Stem cuttings of these twelve individuals were taken in August, 2000, treated with a rooting compound (Hormodin 3), placed in a 1:2 (v:v) mixture of peat:perlite and placed under intermittent mist. Rooting and survival percentages will be calculated and, if necessary, additional cuttings will be taken in the spring of 2001. Surviving clones will be planted in the same field plot that was used for the original field trial.



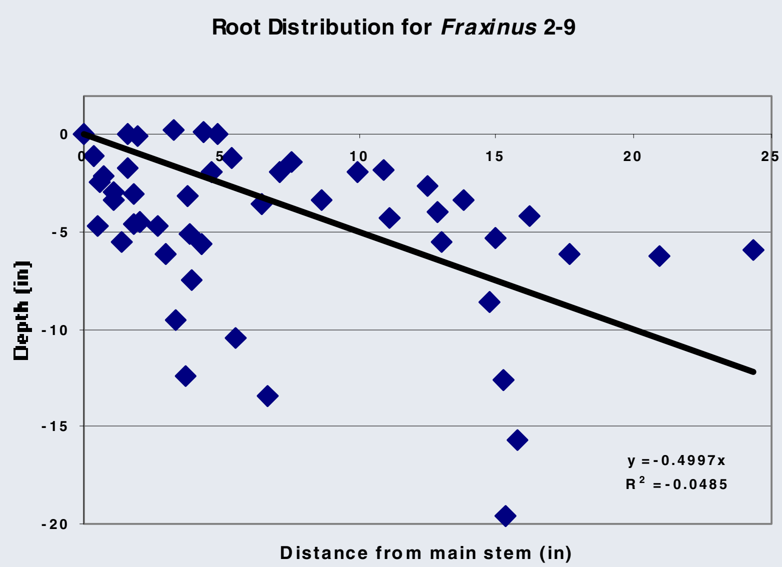
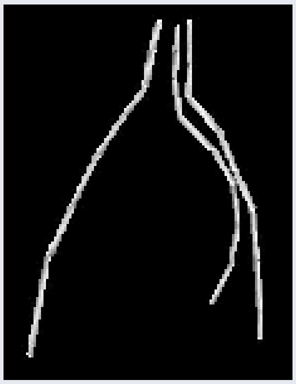


Figure 3. 3-D model (left) and 2-D root distribution projection for* Fraxinus *2-9.



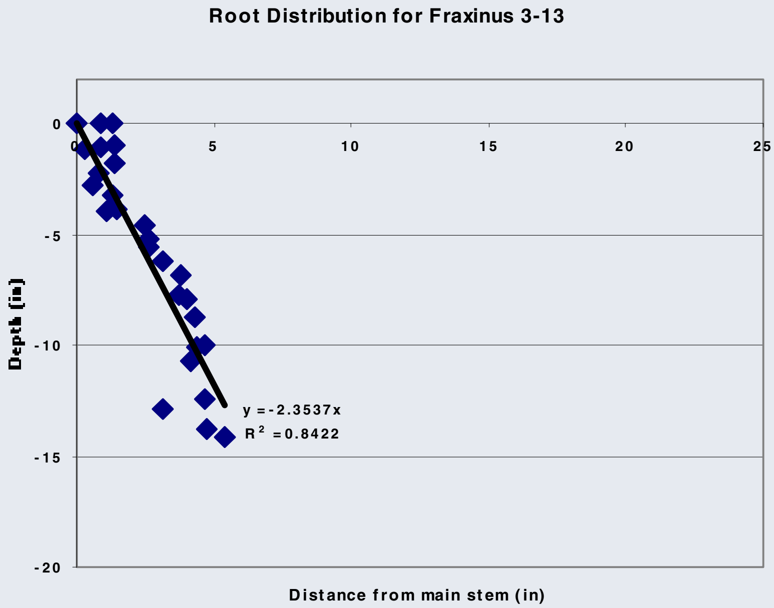
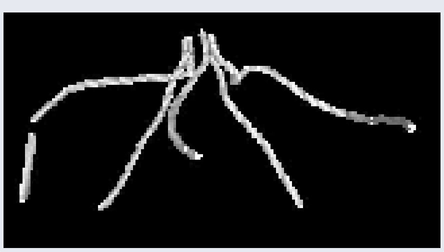


Figure 4. 3-D model (left) and 2-D root distribution projection for **Fraxinus** *3-13.*



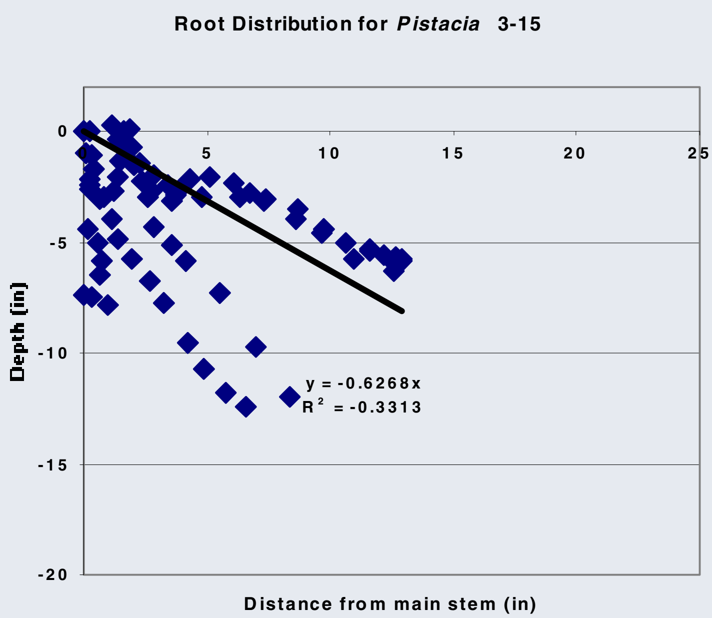
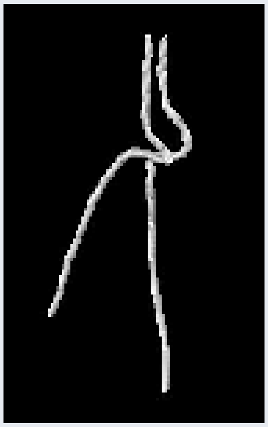


Figure 5. 3-D model (left) and 2-D root distribution projection for **Pistacia** *3-15.*



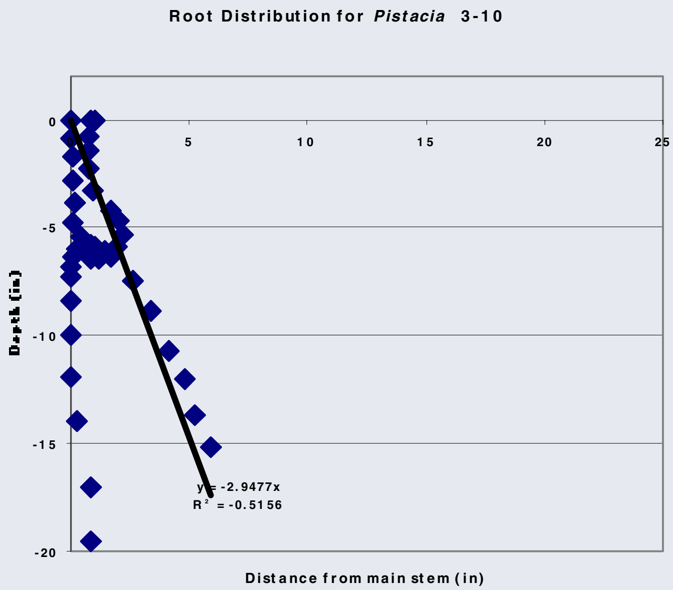
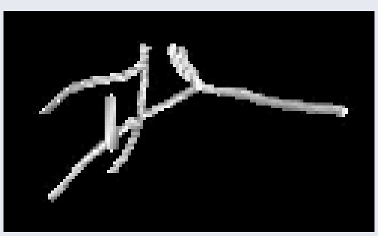


Figure 6. 3-D model (left) and 2-D root distribution projection for Pistacia *3-10.*



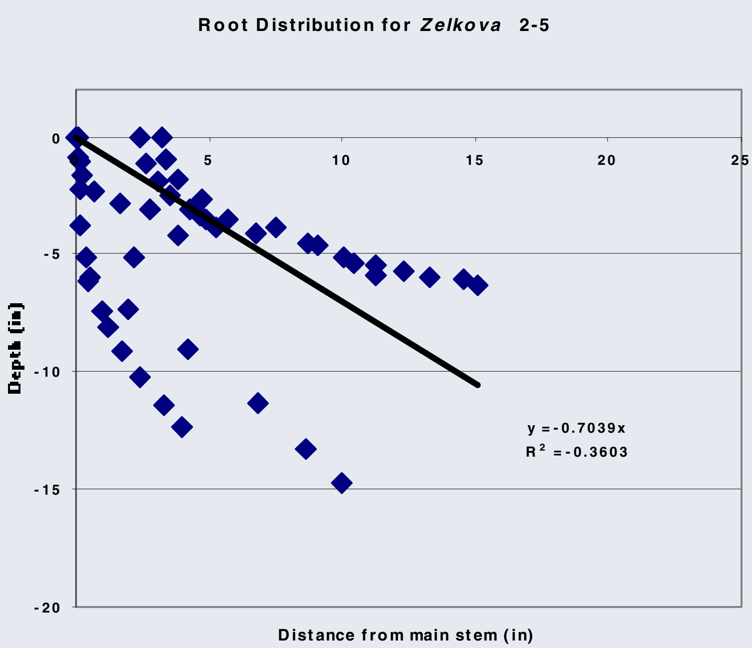
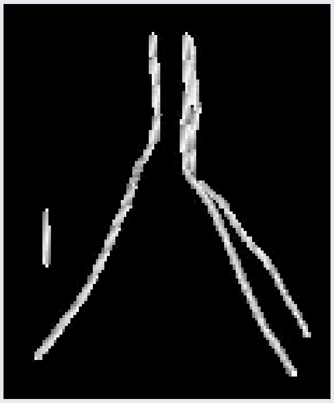


Figure 7. 3-D model (left) and 2-D root distribution projection for Zelkova *2-5.*



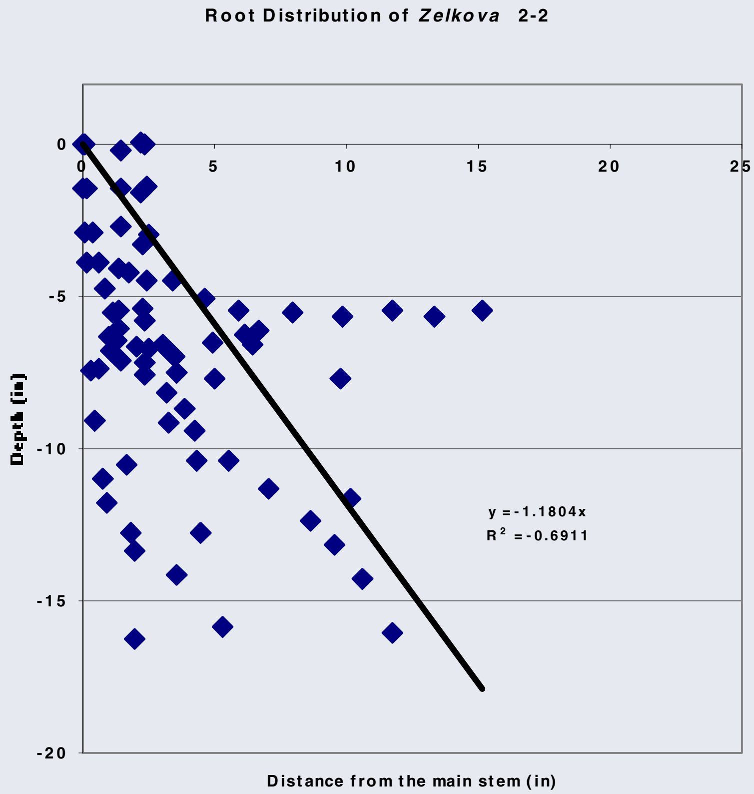


Figure 8. 3-D model (left) and 2-D root distribution projection for* Zelkova *2-2.

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