United States Department of Agriculture

Natural Resources Conservation Service

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Subject: Biology - Geophysical Assistance **Date:** 26 July 2001

To: Dr. Robert Ahrens, Director
National Soil Survey Center
USDA-Natural Resources Conservation Service
100 Centennial Mall North, Room 152
Lincoln, NE 68508-3866

Purpose:
Foresters have become increasingly aware of the potentials of using ground-penetrating radar (GPR) to nondestructively assess the below ground biomass of trees. This past year the NSSC has conducted GPR tree root research on the Atlantic and Gulf Coastal Plains with the USDA-Forest Service. Other Foresters are interested in learning more about GPR and its potential to evaluate tree roots and rooting problems. Brief demonstrations using GPR to assess tree roots and rooting problems were provided to the Davey Resource Group and the Ohio Department of Natural Resources.

Participants:
Jim Doolittle, Research Soil Scientist, USDA-NRCS, Newtown Square, PA
Richard Rathjens, Senior Agronomist, Davey Resource Group, Davey Tree Expert Company, Kent, OH
Alan Siewert, Urban Forester, Division of Forestry, Ohio Department of Natural Resources, Middlefield, OH

Activities:
All field activities were completed on the morning of 26 July 2001.

Equipment:
The radar unit is the Subsurface Interface Radar (SIR) System-2000, manufactured by Geophysical Survey Systems, Inc.[1] The SIR System-2000 consists of a digital control unit with keypad, VGA video screen, and connector panel. A 12-volt battery powered the system. This unit is backpack portable and, with an antenna, requires two people to operate. A 400 MHz antenna was used in this study. The scanning time was 30 nanoseconds (ns). Hard copies of the radar data were printed in the field on a model T 104 printer.

Study Areas:
Three sites were located in areas of coarse-loamy and sandy soils near Painesville, Lake County, Ohio. Each site was located in an urban area. Sites were centered on a "problem" tree, which has experienced poor growth and health due to unidentified causes. Sites were located at the Lake County Home, the Painesville City Green, and Headlands Beach State Park.

Field Procedures:
Grids were established at each site. Grids were located either around or on one side of a "problem" tree and varied in size from 20 by 45 ft to 50 by 40 ft. The grid interval was 5 ft. Pulling the 400 MHz antenna along each

[1] Manufacturer's names are provided for specific information; use does not constitute endorsement.

grid line and in orthogonal directions completed a survey. Upon completion of each survey, radar profiles were printed, reviewed, and interpretations discussed in the field.

Results:

Ground-penetrating radar was used to locate tree roots, assess rooting patterns, and identify the presence of adverse subsurface features (such as compaction, disturbances, and buried fill layers) that affect the below ground biomass and the health of trees. Results were good as GPR provided adequate observation depths and resolution of subsurface features. At each site, GPR provided information on the number and distribution of tree roots, the occurrence of soil compaction, the presence and location of utility lines, filled trenches, and soil horizons.

Closing Remarks:

1. Studies and assessments of soil compaction, traffic pan development, tree roots and features within the surface layers would benefit greatly if the NSSC had a 900 MHz antenna. The highest frequency antenna available at the NSSC is 500 MHz. During the past two years, the NCCS has been involved in several tree root, golf green, and soil compaction studies, investigations of shallow organic deposits in thaw lake basins, and urban projects that require the use of higher frequency antennas. The addendum lists the papers and presentation that pertain to these studies. In these studies either a 900 MHz or 1.5 GHz antenna was loaned or rented by researchers. The availability of these antennas cannot be insured for these projects in the future. I heartily recommend the purchase of a higher frequency 900 MHz antenna.

2. Participants received exposure to GPR and its interpretations. They were able to evaluate the use of GPR in soils and with tree species that they were familiar with. Both were grateful for the assistance provided by NSSC

With kind regards,

/s/ Jim Doolittle/jtc

James A. Doolittle
Research Soil Scientist

cc:
Carolyn G. Olson, National Leader for Soil Investigations, NSSC, MS 34, NRCS, Lincoln, NE
Horace Smith, Director, Soil Survey Division, NRCS, Washington, DC

Addendum

Papers:

She-Kong Chong, Jim Doolittle, Sam Indorante, and Kathy Renfro. 2000. Investigating without excavating: Radar offers a glimpse of subsurface features without digging. Golf Course Management 68(9): 56-59.

Hinkel, K.M, J. A. Doolittle, J.G.Bockheim, F.E Nelson, R. Paetzold, J. M. Kimble,R Travis. 2001. Detection of subsurface permafrost features with ground-penetrating radar, Barrow, Alaska. Permafrost and Periglacial Processes. 12(2): 179-190.

Butnor, J.R., J.A. Doolittle, L. Kressl, S. Cohen, and K.H. Johnsen. Use of Ground Penetrating Radar to Study Tree Roots in the Southeastern United States. Tree Physiology (accepted for publication).

Presentations:

Butnor, J.R., J.A. Doolittle, L. Kress, S. Cohen, D. Delea, and K.H. Johnsen. 2000. Use of Ground Penetrating Radar to Study Tree Roots in the Southeastern United States. 16th Biennial North American Forest Biology Workshop. July 17-21, 2000. Merida, Yucatan, Mexico

Butnor, J.R., J.A. Doolittle, L. Kress, S. Cohen, D. Delea, and K.H. Johnsen. 2000. Use of Ground Penetrating Radar to Study Tree Roots in the Southeastern United States. Advances in Terrestrial Ecosystem Carbon Inventory, Measurements and Monitoring. October 3-5, 2000. Raleigh, NC, USA