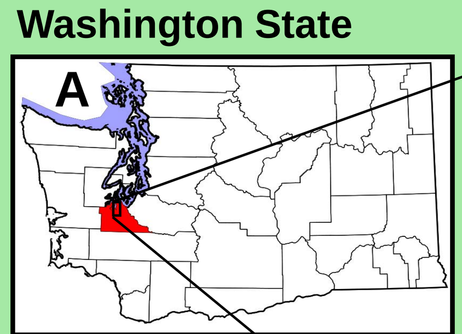
Measuring Fine Root Growth Using Minirhizotron Technology in a Pacific Northwest Second-Growth Forest

Sydney Baker, Claire Cook, and Dylan G. Fischer
Field Ecology Laboratory, The Evergreen State College, Olympia, WA
Contact: fischerd@evergreen.edu

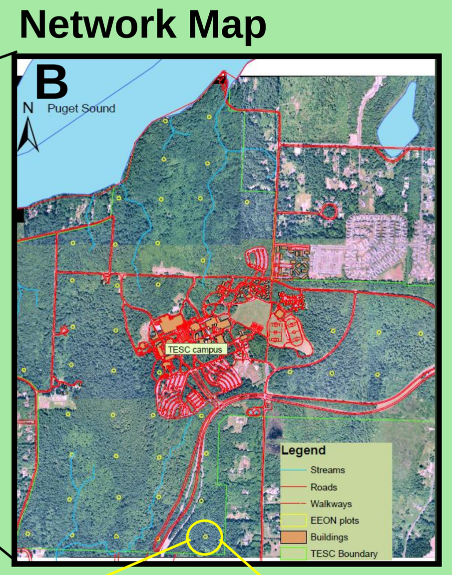
Summary

- Fine root production in is a fundamentally important component of Forest ecosystem Carbon (C) and Nitrogen (N) Cycling
- Understanding ecosystem roles in carbon sequestration requires understanding how roots grow and die
- Methods for the determination of fine root production are problematic because the soil is inherently destroyed through the sampling of fine roots
- Here, we describe the continuous use of a non-destructive technique (Minirhizotrons) to monitor root growth and development between 2007 and 2014
- Minirhizotrons were installed in 40 location in the Evergreen Ecological Observation Network (EEON) plots in 2007.
- We monitored root growth and development through use of a scanner-based technology (The CI-600 root scanner) from 2007-2014
- In summer 2014, we installed a new series of minirhizotrons in 40 new locations.

Washington State



Network Map



Sample Plot

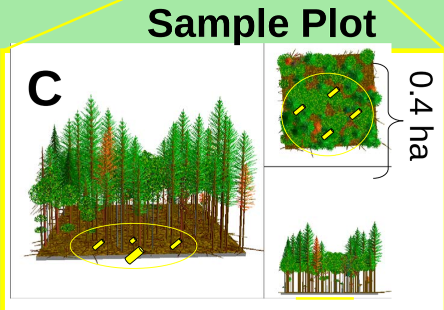


Figure 1. (A) Map of Washington State, USA. **(B)** Map of the EEON permanent plot network located within the Evergreen State College forest reserve. Yellow circles represent 10m radius plots. **(C)** Model representation of an EEON plot (inset; using Stand Visualization System - SVS). The yellow circles represents plot boundaries; four minirhizotron tubes where root measurements are taken are also represented.

INTRODUCTION

•Temperate forest ecosystems can represent a major carbon sink and may even account for missing C in global budgeting (Pan et al. 2011). Fine roots are an especially important component of ecosystem carbon and nutrient cycles (Jackson et al. 1997)

•Nevertheless, dynamics of belowground processes such as fine root growth, death, and decay in temperate forest ecosystems are poorly understood (Vogt et al. 1986).

•Finally, key dominant plant species can play a major role in determining the fine root dynamics (Ellison et al. 2005). Species differences in functional traits can be important as drivers of ecosystem processes (Scott and Binkley 1997, Binkley and Menyailo 2005).

•Our primary goal is to identify biological and season-based patterns in in fine root productivity and turnover in a second-growth forest ecosystem. This research is ongoing, and here we describe the approach to minirhizotron measurement.

Site Photos. Permanent plot photos (2006) demonstrating variability in stand conditions. Photos from left to right show a typical deciduous-dominated stand with *Acer macrophyullum and Alnus rubra* , a typical *Pseudotsuga menziessii* dominated stand, and a mixed stand with very productive *P. menziessii* in the foreground.

STUDY AREA AND METHODS

•This study was conducted in the Lowland Puget Sound, Washington, USA; (**Figure 1A**). The ecosystem is a second-growth temperate rain forest receiving more than 1 meter of annual rainfall with an average annual temperature of ~10° C (TESC weather station; http://rails.evergreen.edu/weather/).

•Data was collected from the Evergreen Ecological Observation Network (EEON; **Figure 1**), a long-term permanent plot network located throughout a 380 ha forest reserve owned and managed by the Evergreen State College.

•The EEON is series of 44, 20 m diameter permanent forest monitoring plots located on a randomized grid approximately 250 meters apart (sample plot **Figure 1**)

•In 10 plots, Minirhizotron tubes (30 cm long) were placed in the soil in four equidistant locations throughout each plot and measured on regular time intervals using a scanner-based technology (CI-600, CID inc, Camas, WA; **Figure 1C, 2**).

•In 2014, We installed 40 new minirhizotron in 10 new plots. These new tubes were 1 m long, and similarly placed and scanned (**Figure 2**). New scans of roots growing along the surface of the new minirhizotrons will occur monthly throughout 2014/2016

Figure 2. Minirhizotron measurement of roots in the EEON plots. Clear plexiglas tubes are inserted into the soil at an angle of 36 degrees up to a meter deep. A minirhizotron scanner (top panels) is then inserted into the tube and images are collected at predetermined depths. The resulting images (bottob right) reflect a 360 scan of the circular tube interface with the soil.

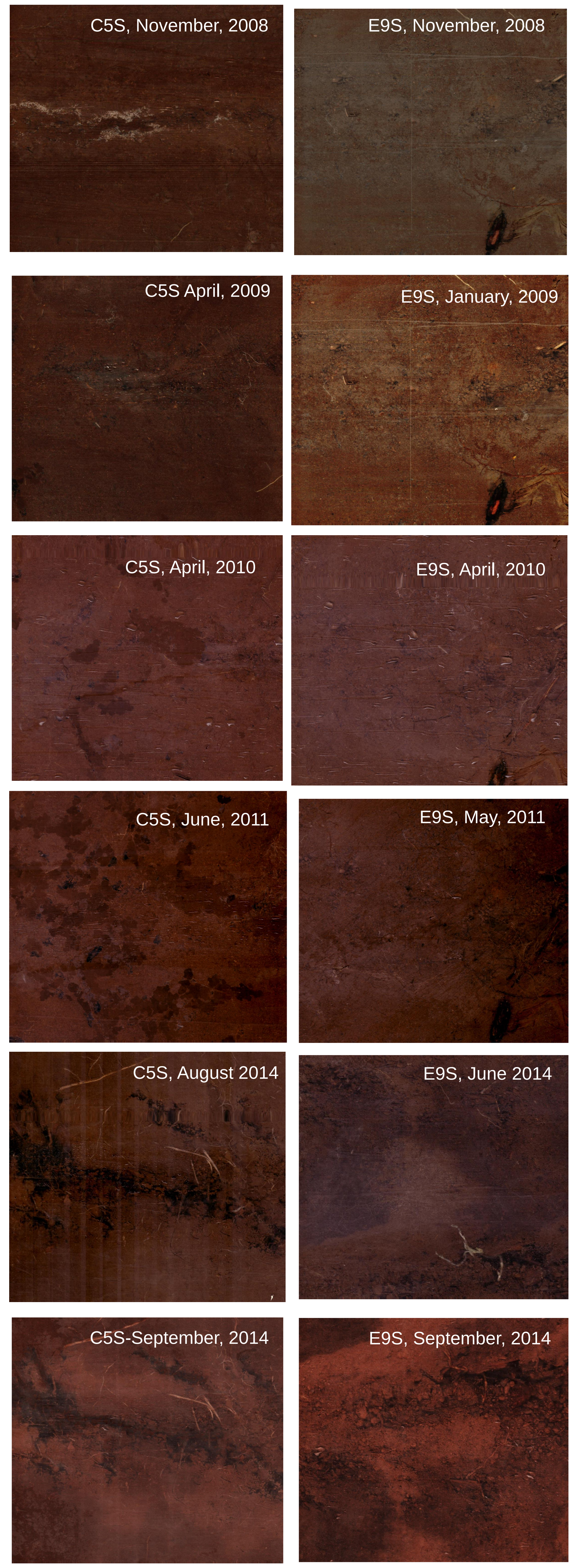
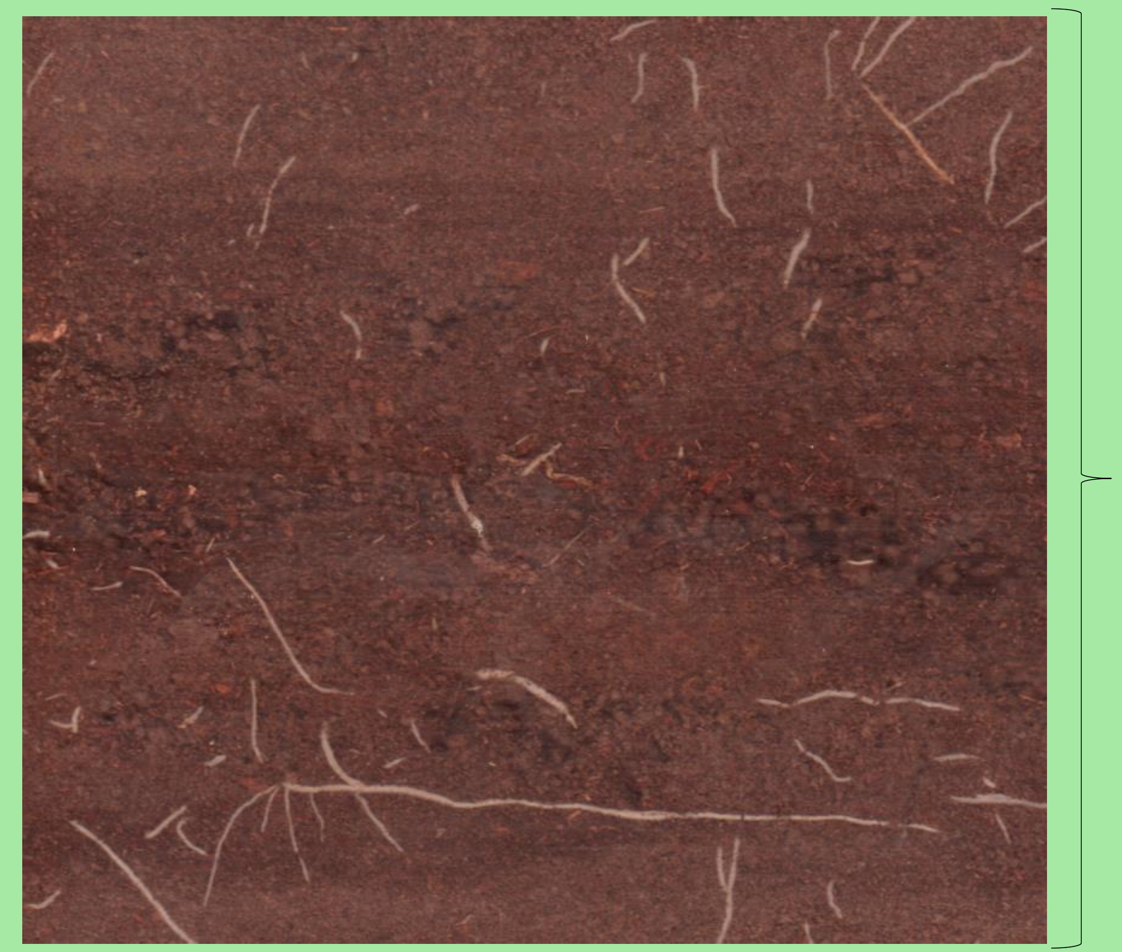


Figure 3. A sequence of minirhizotron images through time at a single plot (E9s). Date of measurement is indicated in the upper-right corner of the image.



20 cm

Figure 4. example image from a Minirhizotron Camera installed in the EEON plots on the Evergreen State College.

Research is ongoing

•High resolution images of minirhizotrons since 2007 show that roots are dynamic and constantly changing in-situ (**Figure 3**)

•Root proliferation in newly installed minirhizotrons shows that roots quickly recolonize and adapt to disturbed soils (**Figure 4**).

•New minirhizotron tubes are allowing expansion of the current measurment of fine root dynamics

•Data is being analyzed using touchscreen technology (**Figure 5**; Rootsnap, CID, Inc. Camas WA) which promises to rapidly expand our current approaches

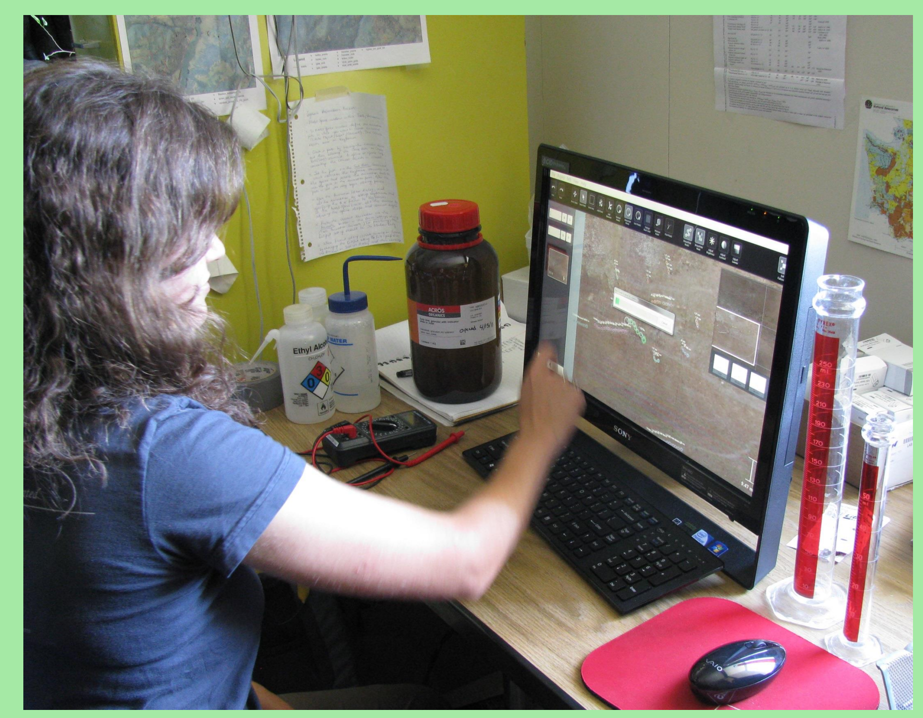


Figure 5. A researcher in the Evergreen Ecological Observation Network lab uses touch-screen technology to analyze images produced by scanning minirhizotron images of roots in the Evergreen State College forest reserve.

Acknowledgements

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