Department of Environmental Sciences
College of the Environment
Western Washington University
Bellingham, WA 98225–9181

ESCI 197C INTRODUCTION TO FIELD RESEARCH
Fall 2026

Tree Movement Project

Due Friday 30 October 2026

Introduction

Nalini Nadkarni is widely recognized as the grandmother of forest canopy science (Nadkarni 2008). In addition to scientific brilliance, Nadkarni is a compelling advocate for forests and human-nature connection. As a National Geographic Explorer she gave a wide-ranging presentation about cultivating human-nature connections in diverse arenas (Nadkarni 2013). Among her approaches was a demonstration that these quintessentially rooted organisms actually move great distances. (Other researchers have demonstrated that entire vines in tropical forest canopies can move up to 30 meters per year, but that is another story.) We will attempt to replicate her measurements and calculations, and then compare her results to ours.

Similar to Nadkarni's demonstration, this project is intended to be evocative. It does not directly include many important sources of variation, including seasonal weather, tree species, tree position relative to other trees or windbreaks, and wind patterns near vs. high above ground. At minimum, it should demonstrate relative mobility in organisms generally viewed as stationary.

Tree Movement Question

(1) How far does a single tree 'move' in a year?

(2) How large is uncertainty in the estimate for (1)?

Field Methods

We will apply the method developed by Nalini Nadkarni (2013).

1 Equipment: paintbrush, paint, drawing paper, timing device or stopwatch, ruler.

2 Select a tree with branches within easy reach. Ideally, the tree should be located at the edge of a forest, or perhaps growing in an open environment. This project likely will work best with a coniferous tree. In her video, Nadkarni used a Douglas fir (*Pseudotsuga menziesii*).

3 Attach the end of a paintbrush to the tip of a living branch (i.e., with green needles).

4 Dip the tip of the paintbrush in wet paint.

5 When you are ready, instruct your research partner to be ready to begin timing.

6 Hold a sheet of drawing paper up to the paintbrush tip up to the branch in a nearly vertical orientation, so that the paintbrush tip will slide continuously along the paper when the branch moves. Take care to avoid impeding branch movement. When the paper is in position, instruct your partner to start timing.

7 At the end of each branch movement (oscillation), move the paper slightly so that the paintbrush will draw a distinct trace in subsequent branch movements.

8 Hold the paper in position for two minutes (120 seconds). Your timing partner should tell you when that time has elapsed. Pull the paper away from the branch at the two minute time.

10 Measure the length of each brush stroke using the ruler. To make subsequent calculations easier, measure brush strokes in units of centimeters (cm). If brush strokes form arcs or other nonlinear shapes, measure the lengths of tangent lines for each arc and sum the tangent line lengths for each arc. Write your length measurements on the drawing paper beside each brush stroke.

11 Count the number of small twigs on the branch you attached the paintbrush to. (Is this number larger, smaller, or similar to the number of twigs on other branches of the tree?)

12 Count or estimate the number of branches on the tree. (Is this number larger, smaller, or similar to the number of branches on trees nearby? i.e., how 'representative' of other trees is the one you measured?)

Data Analysis

1 Multiply the number of minutes in an hour by the number of hours in a day by the number of days in a year (60*24*365). Divide by 2, because you measured for 2 minutes.

2 Multiply the number of twigs per branch by the number of branches on your tree.

3 Sum the lengths of all brush strokes you measured, recorded within the 2 minute interval.

4 Calculate the average length and standard deviation of the brush strokes you measured.

5 Multiply the result of (1; minutes) by the result of (2; number of twigs) by the summed brush stroke length (3; cm). Feel free to convert to more a more tangible unit, such as kilometers (km). This is a crude estimate of annual distance 'moved' by your tree.

6 Multiply the result of (1; minutes) by the result of (2; number of twigs) by the standard deviation in brush stroke length (4; cm). This is a crude estimate in variability or uncertainty in annual tree movement distance.

7 How does your estimate compare with Nadkarni's? (300,143 km/yr or 7 times the length of Earth's circumference)

8 Consider other sources of uncertainty, including variation in (1) number of twigs/branch, (2) number of branches per tree, and (3) wind speed among hours in a day or days in a year. (Is today relatively calm or is wind today particularly strong? Is wind today gusty – variable?)

References

Nadkarni, N.M. 2008. *Between Earth and Sky: Our Intimate Connections to Trees*. Univ.California Press, Berkeley, CA

Nadkarni N. 2013. For the love of trees. *National Geographic Live.* [online] https://www.youtube.com/watch?v=7SwiRJJFm8Y

Brush stroke data

Stroke no.	Distance (cm)	Notes