

Heterotrophic and autotrophic soil respiration in response to fertilization and reduced throughfall at the Virginia Tier III Site

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Introduction

Carbon (C) from the terrestrial biosphere is one of the main reservoirs in the global C cycle. Soils are the largest terrestrial C pool and soil CO₂ efflux [i.e., soil respiration (R_S)] is the second largest flux in the C cycle. Thus, even small changes in this C pool and flux have the potential to impact atmospheric CO₂ concentrations.

Afforestation in general, and managed forests specifically, can mitigate atmospheric CO₂ concentrations by sequestering C in biomass and soil organic matter.

Intensive management of loblolly pine forests have shown appreciable increases in productivity since widespread establishment of plantations in the 1950's and 60's potentially making intensively managed pine plantations large C sinks.

To quantify net ecosystem productivity (NEP), or C storage, from estimates of net primary productivity (NPP) requires the separation of soil heterotrophic, microbial respiration (R_H), and from soil autotrophic, root-derived respiration (R_A) as the components of total soil CO₂ efflux R_S. This allows NEP to be estimated by: NEP = NPP - R_H.

Objectives

1. Provide a partitioning coefficient of R_H in order to allow for the quantification of C sequestration in managed loblolly pine forests throughout the southeastern U.S.
2. Develop a model to predict R_S, R_H, and R_A as impacted by fertilization and decreased throughfall.

Virginia Tier III Site

The Tier III sites have been chosen in order to span the full range of climatic conditions (Fig. 1) where loblolly pine is intensively managed in the southeastern U.S.

The Virginia site is in a managed 9-year-old loblolly pine plantation in the Appomattox - Buckingham State Forest located in the Piedmont of Virginia (Fig. 2).

The study utilizes large (1.3 ha) plots in a fully replicated (n=4) 2 x 2 factorial, randomized complete block design including fertilization (optimal nutrition, no addition) and throughfall reduction (0, 30%; Fig. 3).

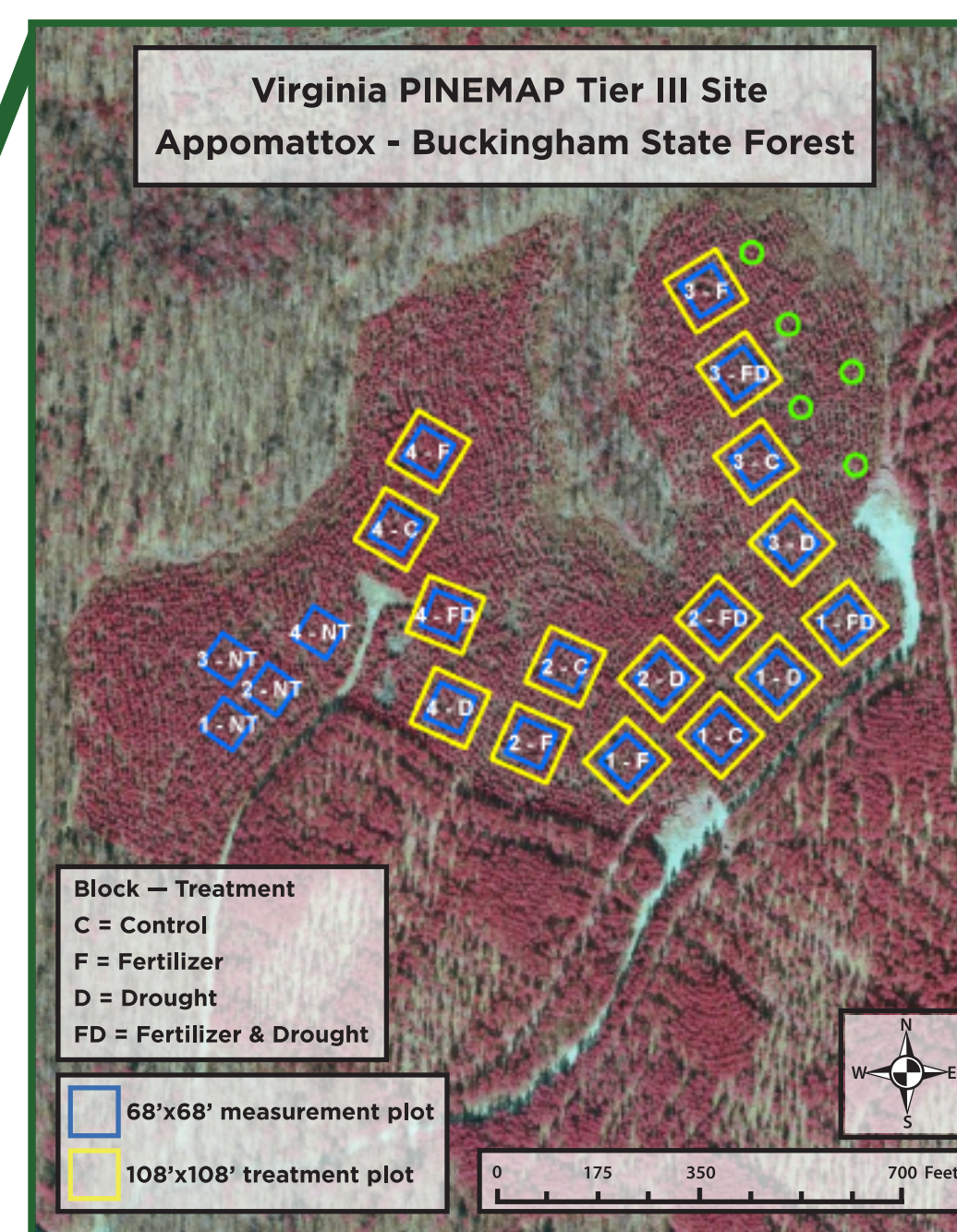


Figure 2 - Virginia Tier III plot layout.

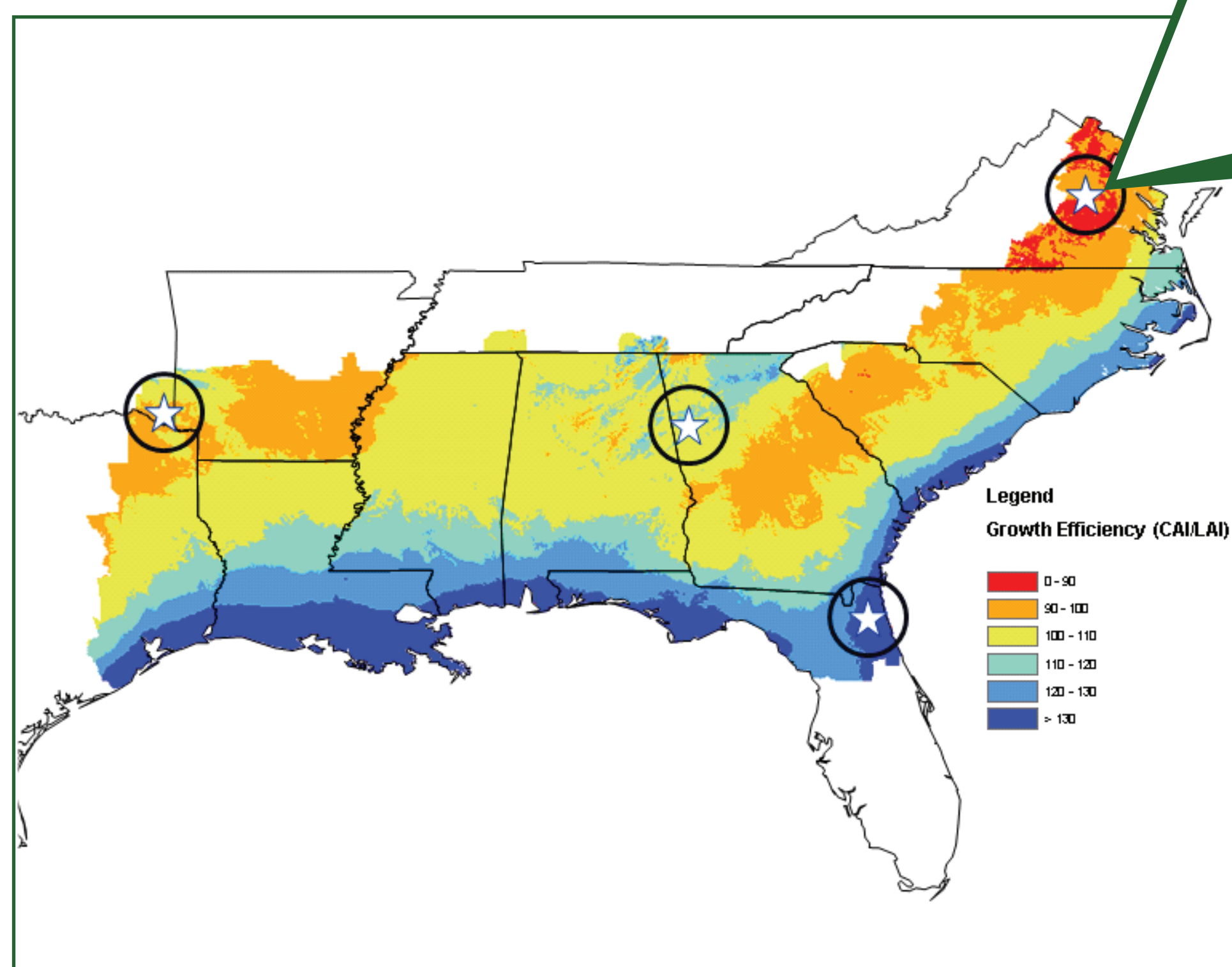


Figure 1 - Locations of the PINEMAP Tier III sites.



Figure 3 - Throughfall manipulation plot.

Methods

Collar Installation

To quantify R_H, we installed root severing collars which cut off the tree C supply to the roots which over time reduces R_A inside the collar to zero and R_S = R_H (Fig. 4).

Root severing collars constructed from steel conduit (15.2 cm diameter and 35 cm length; Fig. 5) are driven flush to the ground (Fig. 6). Three subsamples per plot were installed (48 total). Subsamples in the throughfall exclusion treatment were placed on the edge of the exclusion covers.

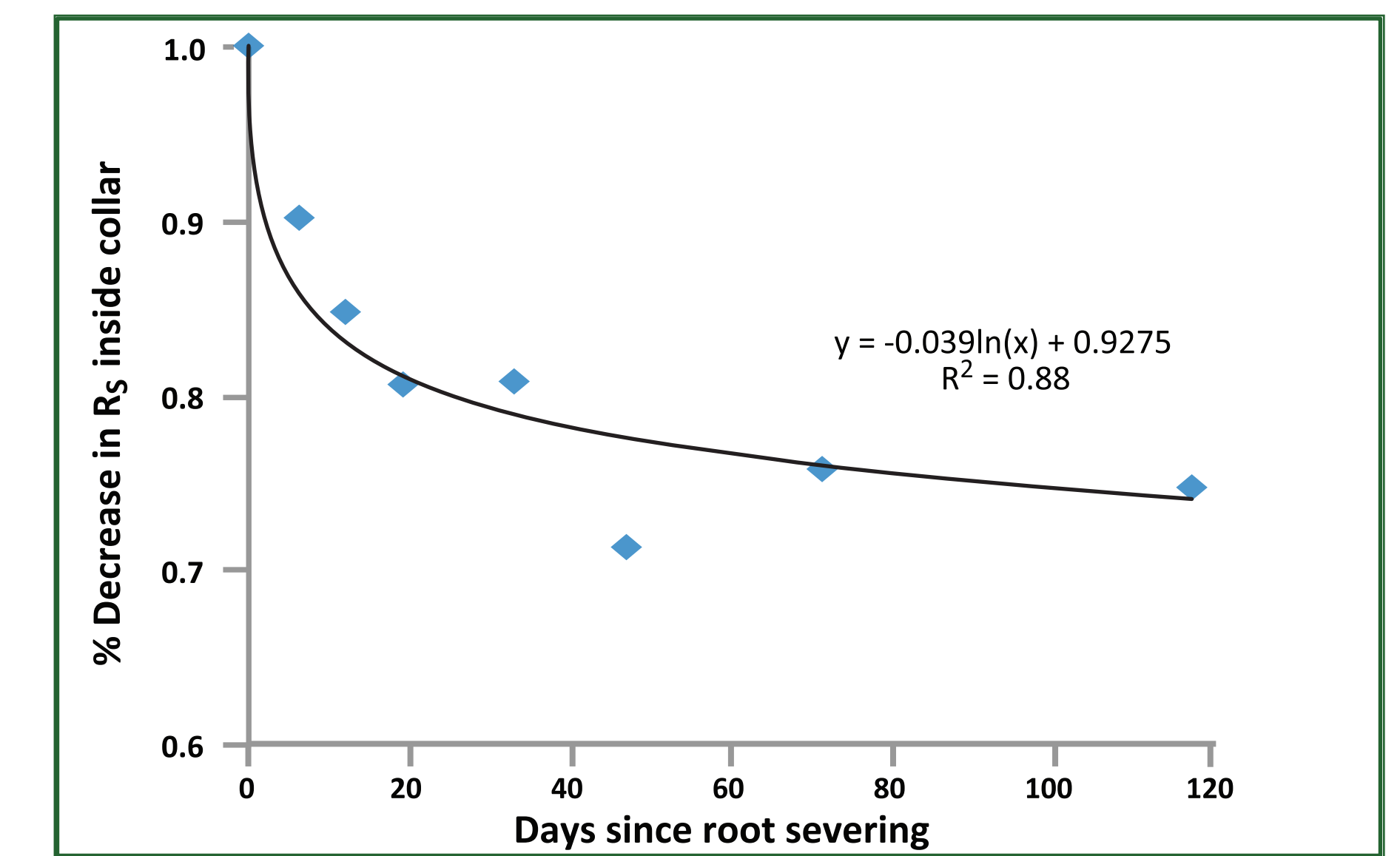


Figure 4 - Percent decrease in R_S inside the collar relative to adjacent outside collar measurement. The decrease is presumptively due to reductions in root carbohydrates over time reducing R_A to zero.



Figure 5



Figure 6



Figure 7

Sampling Procedure

At each subsample location, R_S will be measured in and adjacent to the root exclusion core using a modified Li-Cor 6200 portable gas analyzer system (Fig. 7).

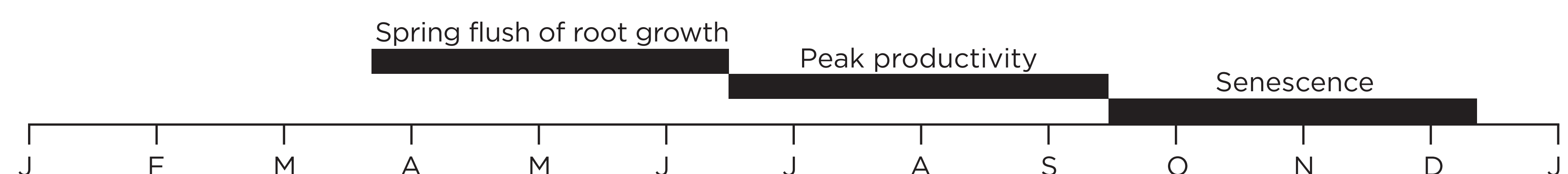
R_S measurements will be taken approximately every 2 weeks to measure the decline in R_A over the course of a three-month interval.

Soil temperature and moisture measurements will be taken adjacent to the collar during each measurement.

After each installation roots inside the collars will be collected for the determination of root surface area and dry weight.

Seasonal Measurements

Measurements will be taken 3 times over the course of the growing season.



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