



A Comparison of Soil CO₂ Efflux of Mid-rotation Loblolly Pine (*Pinus taeda* L.) and the Partitioning of Heterotrophic and Autotrophic Respiration

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Introduction

Terrestrial ecosystems can sequester large amounts of carbon from the atmosphere. Once in the ecosystem, fixed carbon can be stored or respired back to the atmosphere. Respiration is a component of productivity affecting the net production of an ecosystem. Belowground respiration occurs in two forms: autotrophic (roots) and heterotrophic (microbes). Loblolly pine plantations are common and highly productive ecosystems found throughout the southeastern United States. In order to understand the role of respiration in loblolly pine ecosystems and calculate net ecosystem productivity, we must determine the amount of soil CO₂ efflux from heterotrophic and autotrophic components.

The objective of this study was to determine the amount of soil CO₂ efflux from heterotrophic and autotrophic components, and to compare the findings with those of an earlier study.

Hypothesis

Our hypothesis was that the fraction of heterotrophic soil CO₂ efflux will reach a steady state of approximately 0.84 after 60 days.



Figure 1. Seven-year old loblolly pine stand in McCurtain county near Broken Bow, OK..



Figure 2. The blue flags indicate the sample site. The Li-Cor 8100 was used to measure soil CO₂ efflux, and the measurements were recorded in the data logger.

Methods

- Autotrophic and heterotrophic belowground soil respiration and soil temperature were measured on a seven-year old loblolly pine stand located in McCurtain county near Broken Bow, OK (Figure 1).
- 48 sample points were taken every 2 to 4 weeks from June through the first part of August, 2014.
- At each sample point, a 32 cm long by 10 cm diameter collar was previously installed to sever and exclude roots.
- Soil CO₂ efflux was measured with an infra-red gas analysis system (Li-Cor 8100, Li-Cor Environmental, Lincoln, NE) and custom cuvette (10 cm diameter).
- The fraction of heterotrophic soil respiration was calculated by dividing respiration measured in the collar where roots no longer were active by respiration measured outside the collar that included both heterotrophic (microbial) and autotrophic (root) respiration.
- Soil temperature was taken with a TH2 soil temperature probe (10 cm depth).

Results

CO₂ efflux rates were higher than those of the first study due to the higher soil temperature for that time of year (Figure 3). We found that the fraction of heterotrophic respiration was comparable to the assumption that heterotrophic respiration accounts for about 84% of total respiration and supports the assumption that 60 days after driving the collars, and eliminating root activity, this ratio is fairly steady (Figure 4).

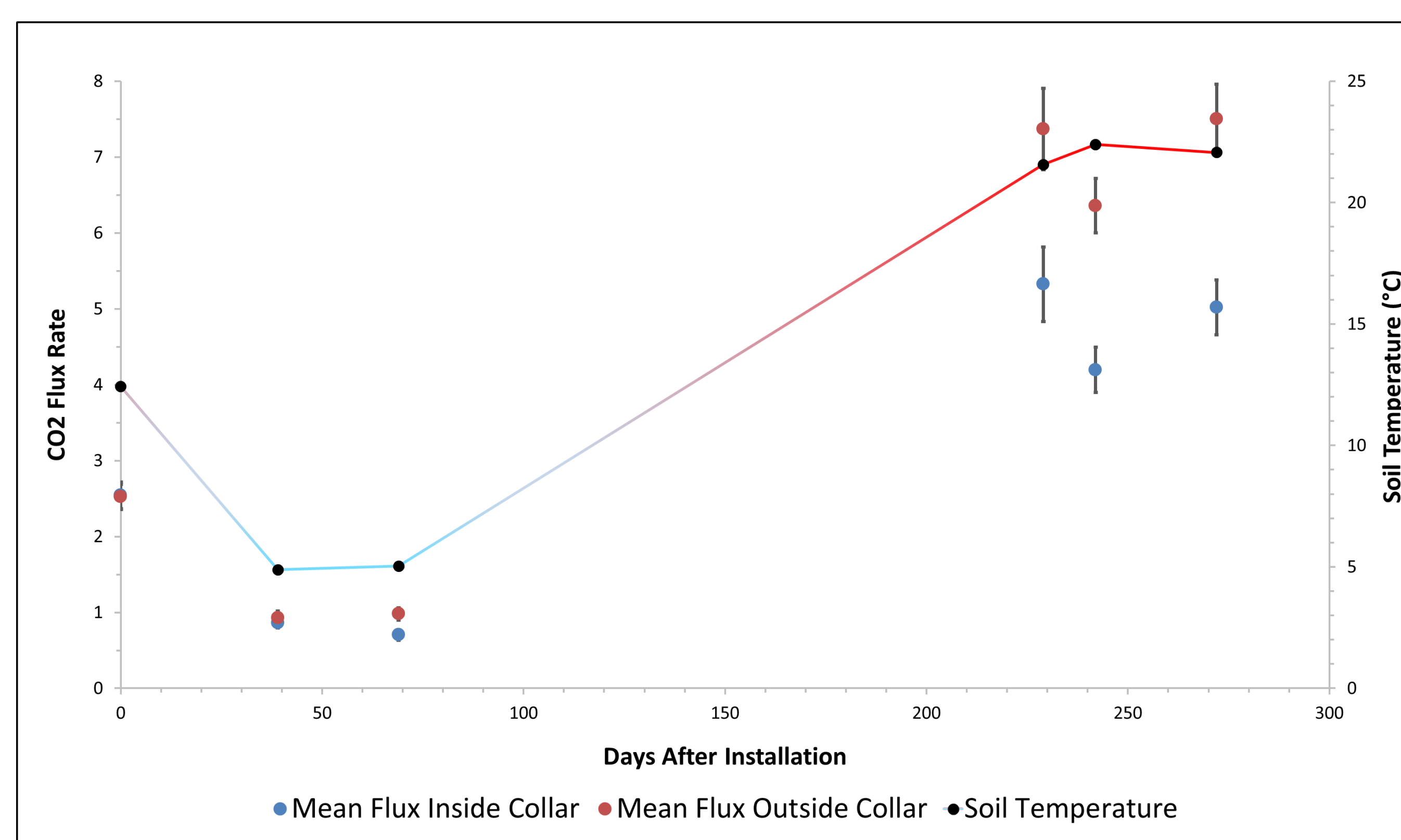


Figure 3. Change in CO₂ flux rates, both inside and outside the collar, after installation. Temperature is scaled on the graph for comparison.

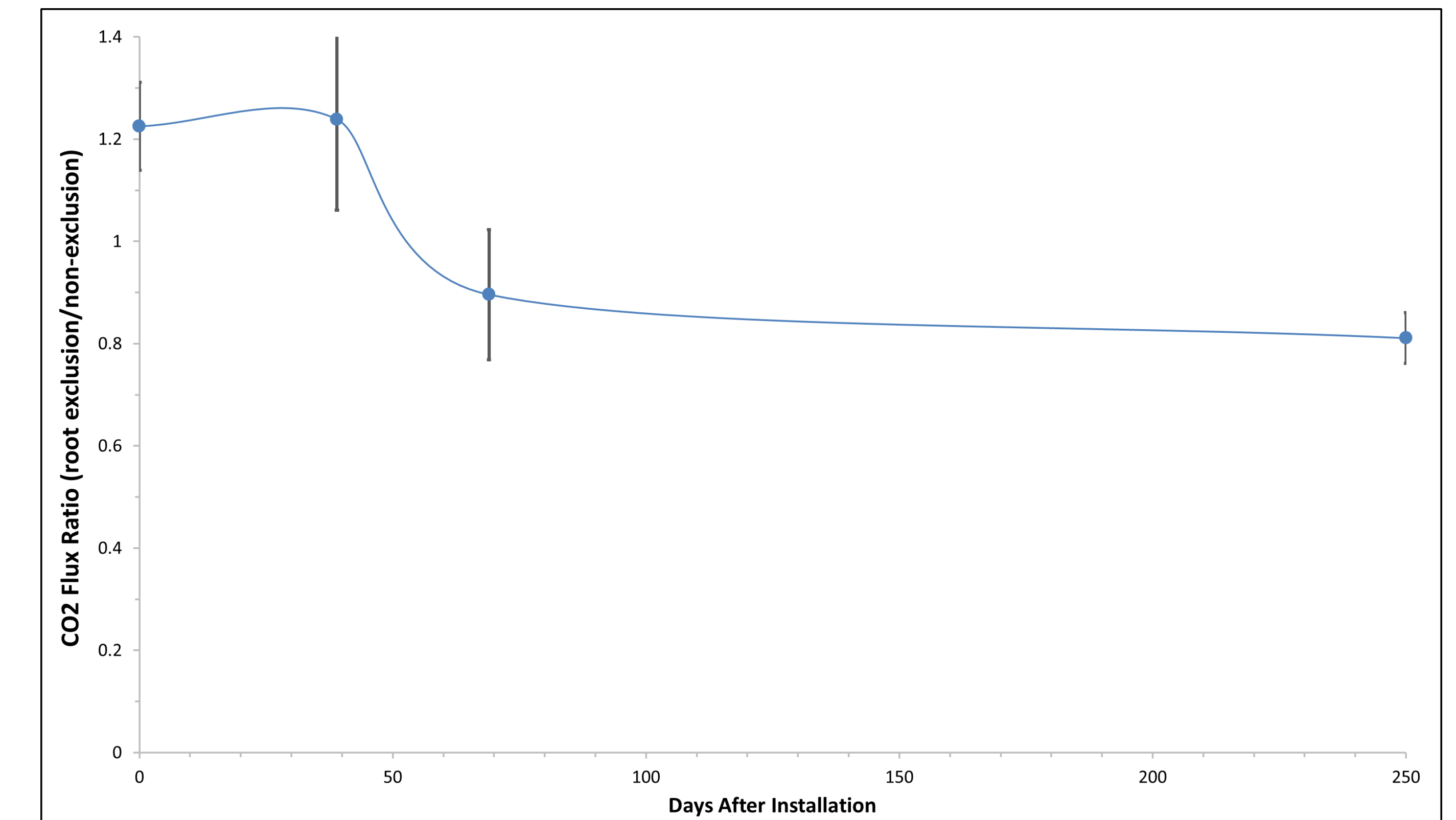


Figure 4. Change in soil CO₂ efflux ratio after collar installation.

Conclusion

An earlier study had shown that heterotrophic respiration accounted for about 84% of total soil respiration based on the assumption that roots severed by the collars would not affect total soil respiration after 60 days. However, the study only measured up to 69 days and it was not known if there was a change in soil CO₂ efflux due to autotrophic or heterotrophic respiration after 60 days. This study which measured the same sample sites of the previous study about 180 days later indicates that after 60 days the soil CO₂ efflux ratio does remain steady for a longer period of time.

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