CO_2 emissions and mass loss from decomposing woody litter in a managed Sitka spruce forest

Olajuyigbe Samuel[1]*, Saunders Matthew[2], Tobin Brian[1], Tene Armand[1], Gardiner Paul[1] and Maarten Nieuwenhuis[1]

[1]School of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Ireland

[2] School of Biology and Environmental Science, University College Dublin, Ireland

*samuel.olajuyigbe@ucd.ie, http://www.ucd.ie/carbifor/index.html

Introduction

Woody litter (brash) is a conspicuous element of the forest floor, where it serves various functions, *e.g.* a protective road-bed for extraction equipment, increasing habitat diversity, enhancing seedling survival and functioning as a significant reservoir for nutrients. Thinning and timber harvesting produce a pulse of brash input consisting of tree tops, dead trees, branches and twigs. Heterotrophic respiration from brash is an important component of total forest ecosystem respiration, especially immediately following disturbances such as thinning and harvesting. Brash decomposition results in CO_2 emission, fragmentation and leaching of organic matter to the soil. Studies isolating respiratory losses and investigating rates of decomposition are few; however, they are essential for accurate estimates of forest carbon budgets. This study aims to quantify the CO_2 flux from thinning lines (brash lanes) and the forest floor (without brash) of a Sitka spruce (*Picea sitchensis* (Bong.) Carr.) forest using static chambers and mass loss from decomposing brash using decomposition bags.

Methods

Ten collars were inserted into the soil under the forest canopy and in the brash lanes. Measurements of CO_2 concentration were carried out using an Infra Red Gas Analyser connected to static chambers before and after a thinning event. Soil moisture content and surface temperature were measured using thetaprobes and tiny tag loggers, respectively. Emissions from brash were estimated based on the difference between fluxes in the brash lane and the forest floor.

Fresh brash of known weights were placed in 36 mesh bags (1.5m by 1m) and left in 6 brash lanes to monitor the mass loss of the material. Six litter bags (one from each brash lane) were collected after 3, 6, 12 and 18 month intervals and assessed for mass loss.

Results and Discussion

It was estimated that brash covered ~14.3% of the 25.8 ha forest floor space. The carbon loss due to respiration from the forest floor (soil, roots and fine litter) was 4.74 T C ha^{-1} yr^{-1} and 1.78 T C ha^{-1} yr^{-1} from brash material (Fig 1).

The mass loss from decomposition bags after 18 months was 38% of the initial mass (Fig 2).

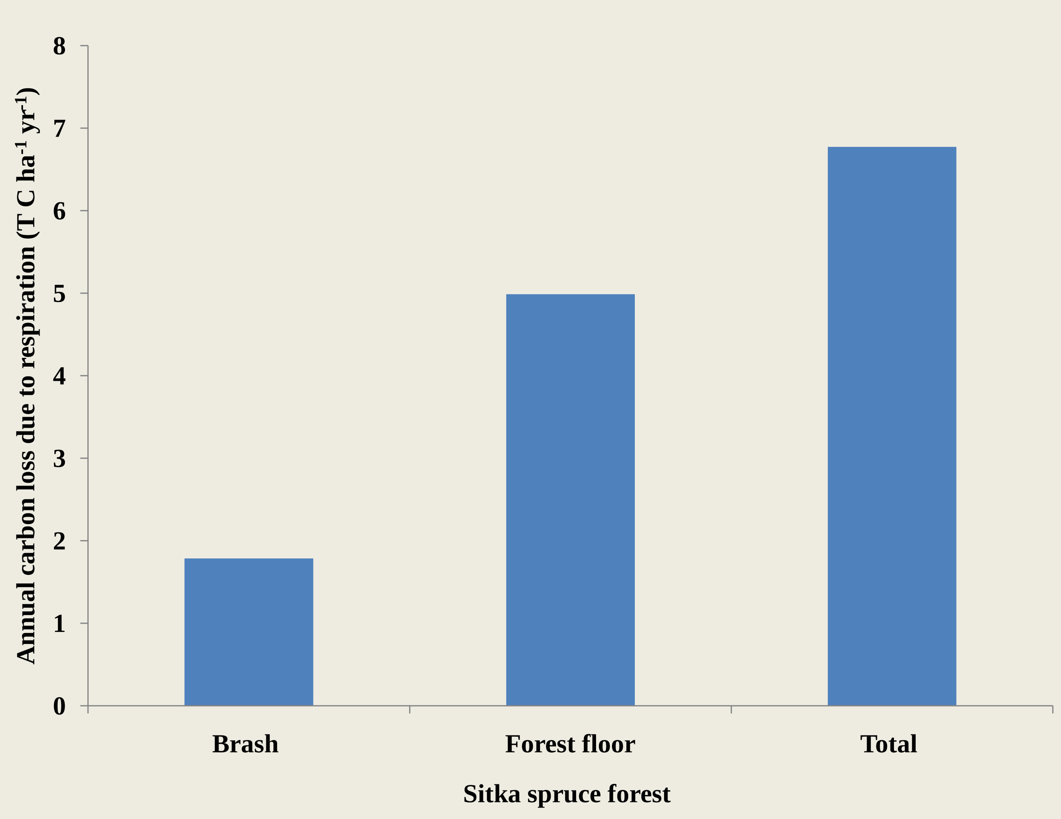


Fig 1. Annual carbon loss from the Sitka spruce brash and forest floor due to respiration

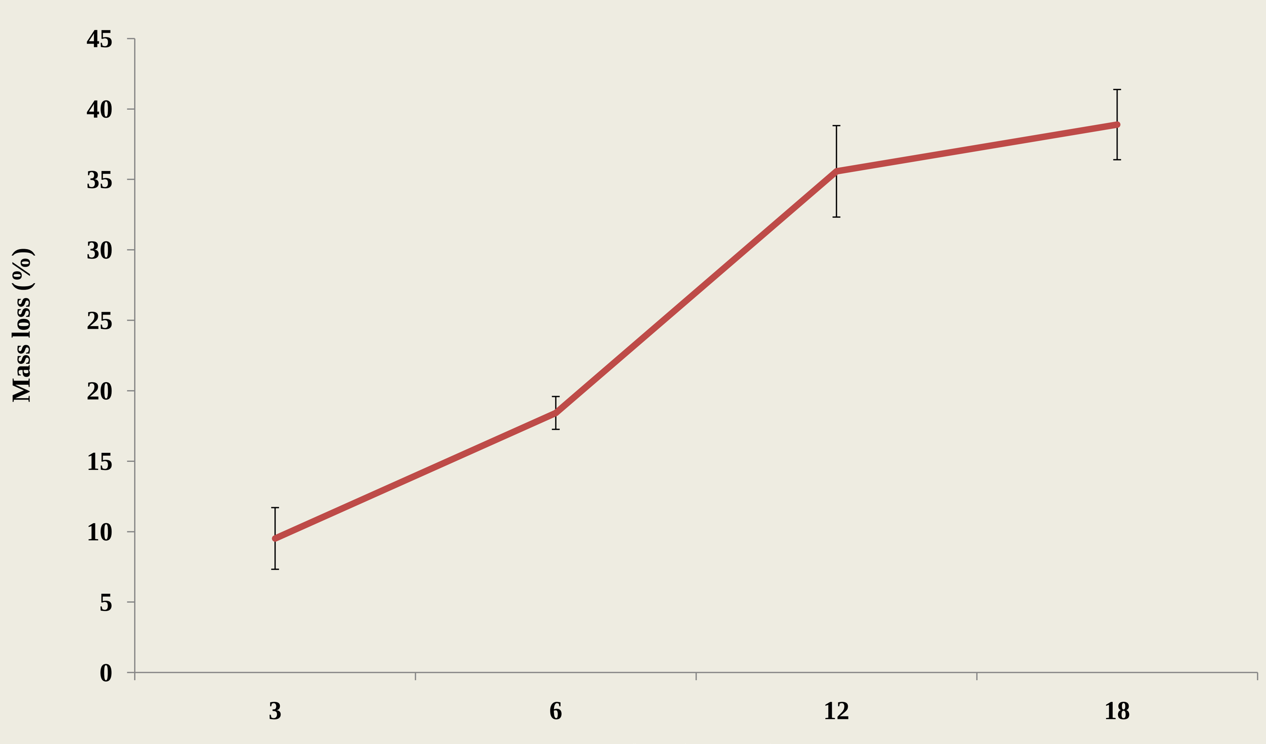
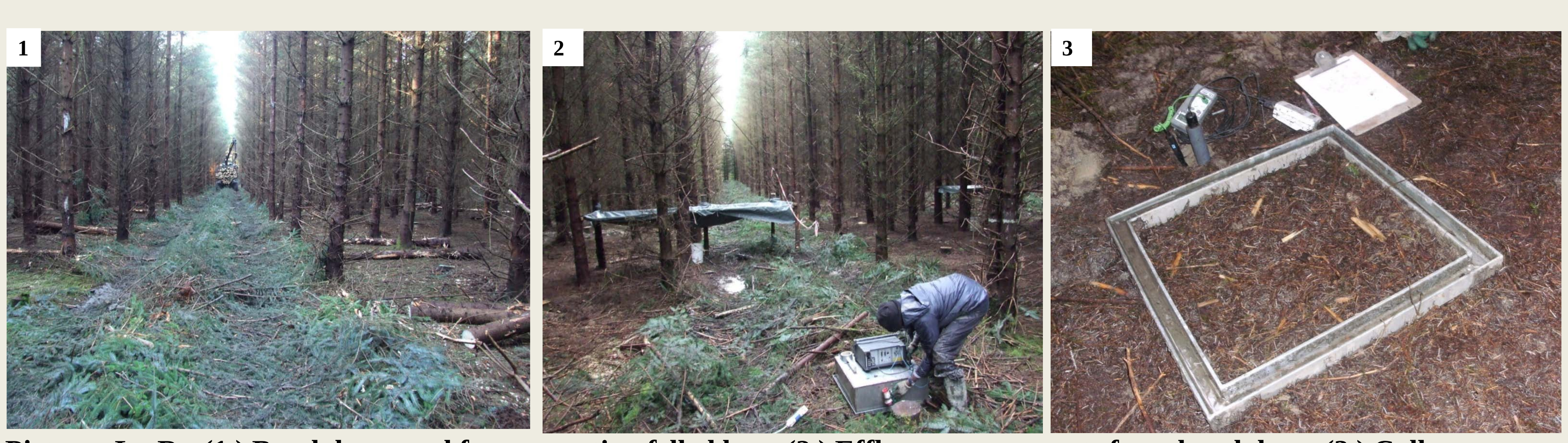


Fig 2. Percentage mass loss from brash decomposition bags (mean values ± standard error)



Pictures L - R : (1.) Brash lane used for evacuating felled logs, (2.) Efflux measurements from brash lane, (3.) Collar inserted into forest floor and thetaprobes used for soil moisture measurements.

Pictures L - R : (1.) Forest floor, (2.) Efflux measurements' set up (3.) Infra red gas analyser and static chamber.

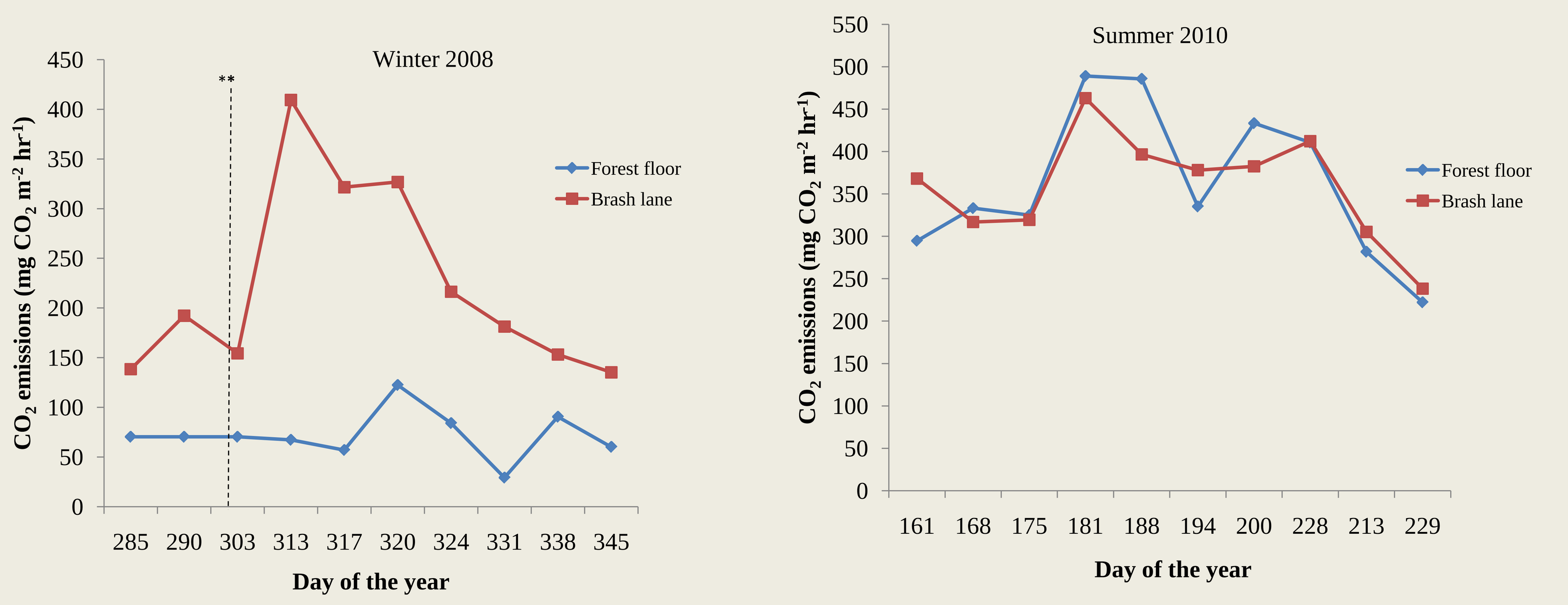


Fig 3 (a and b). CO_2 emissions from brash lane and forest floor during two seasons in a Sitka spruce forest (** thinning event).

**There was a 200% rise in the CO_2 emissions from the brash lane in response to the thinning event. The emissions measured in the summer of 2010 were higher in the forest floor than the brash lanes (Fig 3a and b). This was probably due to the higher moisture content in the brash lane during this season.

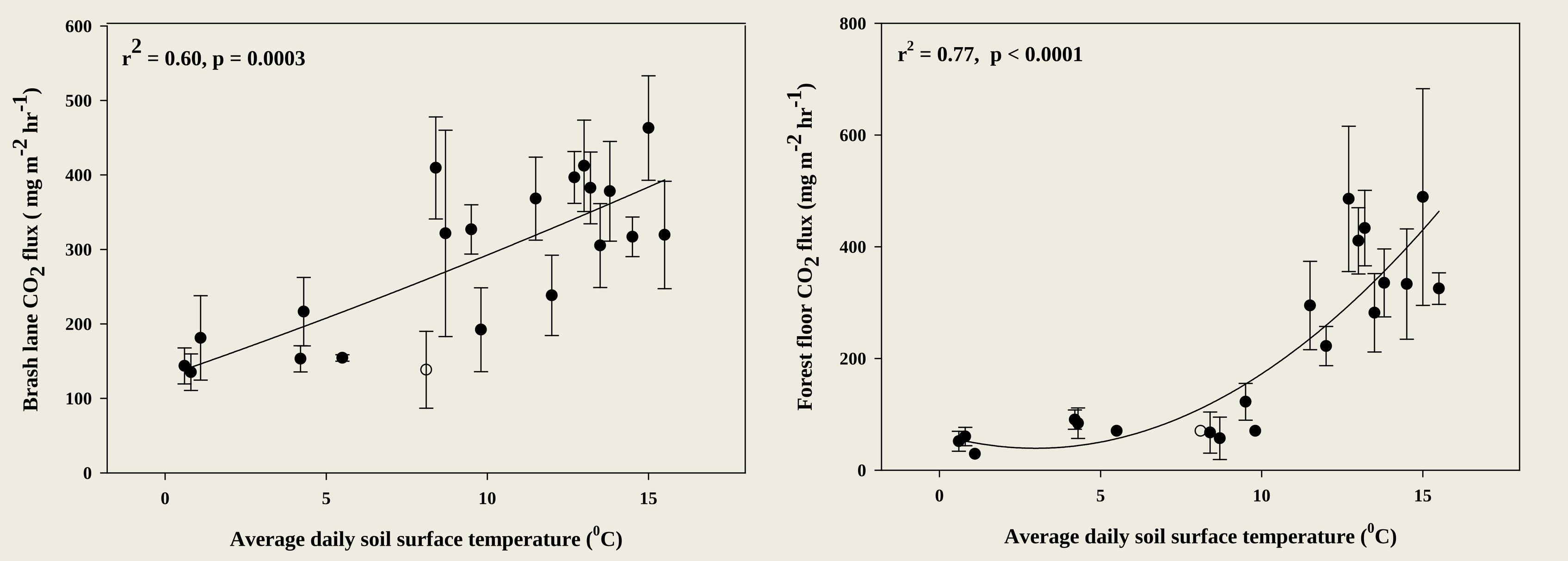


Fig 4 (a and b). Effect of soil temperature on CO_2 efflux from brash lane (a) and forest floor (b) (mean values ± standard error).

Soil temperature positively influenced the emission of CO_2 from the brash lane and forest floor but had a more pronounced effect on the forest floor (Fig 4a and b). However, high soil moisture seemed to limit emissions from the forest floor (Fig 5a and b).

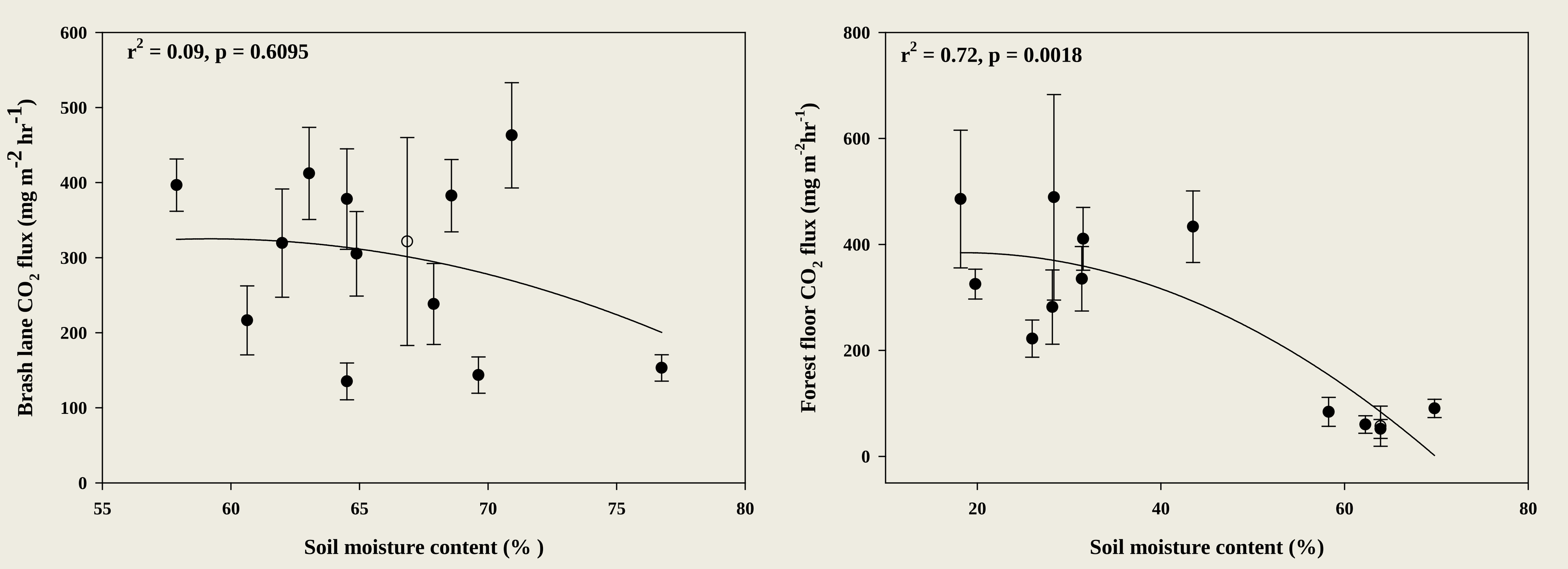


Fig 5 (a and b). Effect of soil moisture on CO_2 efflux from brash lane (a) and forest floor (b) (mean values ± standard error).

Conclusion

After 1.5 years, woody litter had decomposed by 38% of its initial mass. Temperature was a major driver of total respiration and decomposition, however, a high soil moisture content seemed to be limiting. The CO_2 emissions from brash lanes were lower than that from the forest floor, during summer 2010. This was probably due to live roots, higher input of litter from the forest canopy and lower moisture content, when compared with the brash lane. Heterotrophic respiration from woody litter contributed 26% of the total respiration from the forest floor.

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