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Roots of understory species in maritime pine forests

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ABSTRACT

Unfortunately there is commonly an overemphasis on dominant trees in forest studies that ignores an important functional component of the forest ecosystem: the understory species. In maritime pine (*Pinus pinaster*) plantation forests, previous work had shown that it could make up 6.7 % of total aerial and 28 % of total ecosystem root biomass. We conducted a study on four different dominant understory species with varying density of the understory species of interest. In all of the twenty stands (five per understory species) number and dimensions of the pine trees were recorded permitting estimations of aerial and coarse root biomass of the pines. Biometrical measurements of the understory vegetation as well as destructive harvests were carried out in six 1 m^2 plots for each of the twenty stands for: aerial, coarse root and fine root biomass. The first results show that understory represents on average 4.9 % of total ecosystem aerial biomass and 29.8 % of total ecosystem root biomass. The use of Root/Shoot ratios together with biometrical data and average nutrient concentrations will be explored to derive tools for estimating carbon and nutrient pools in the understory vegetation from easily accessible variables.

INTRODUCTION

Understory species in forest ecosystems, although they usually represent less than 1% of the aboveground biomass of typical forests in the Northern hemisphere, have a disproportionate ecological importance, with five main characteristics: 1) contribution to forest biodiversity, 2) competition interactions with regeneration phase of dominant trees, 3) ability to create links with overstory, 4) influence on energy fluxes and nutrient cycling, 5) varied responses to disturbances (Gilliam 2007). In maritime Pine plantations, which have a low leaf area index, understory can represent a more important part of the total ecosystem biomass. As such it is important to get information on above but also belowground of understory biomass. Indeed, only a few studies report on both above and belowground production in conifers stands (Helmisaari et al. 2002) and understory is rarely considered (Sebei et al. 2001). Allometric relationships have been developed to derive contribution of understory in pine forests to carbon stocking and nutrient dynamics, by linking dendrometric measurements to biomass and nutrient content (Porté et al. 2009), but this concerned only the aboveground part of understory biomass. The objective of our study was to add to these allometric relationships, the contribution of belowground understory biomass to carbon and nutrient pools in maritime pine forests.

METHODS

We conducted this study on four different dominant understory species in maritime pine (*Pinus pinaster*) plantation forests. Each understory species was investigated in five different stands with varying density of the understory species of interest (from low to high density understory vegetation). In all of the twenty stands number and dimensions of the pine trees were recorded permitting estimations of aerial and coarse root biomass of the pines. Biometrical measurements of the understory vegetation as well as destructive harvests were

carried out in six 1 m^2 plots for each of the twenty stands. In each of these 1 m^2 plots we destructively sampled aerial biomass (1 m^2 basis), coarse root biomass of the understory (0.25 m^2 soil pits down to 30 cm in the soil) and fine root biomass of understory and maritime pine (four to six 8 cm diameter soil cores down to 30 cm soil depth). Total amounts of fine roots were estimated down to 120 cm using existing depth distributions.

RESULTS AND DISCUSSIONS

The first results show that understory represents on average 4.9 % (range 0.2–24.7%) of total ecosystem aerial biomass and 29.8 % (6.9–55.4%) of total ecosystem root biomass, with on average 65.7% of fine root biomass (28.5–78.9%). This percentage of total ecosystem biomass varied according to the understory dominant species for the aboveground but not the belowground biomass (Fig. 1.).

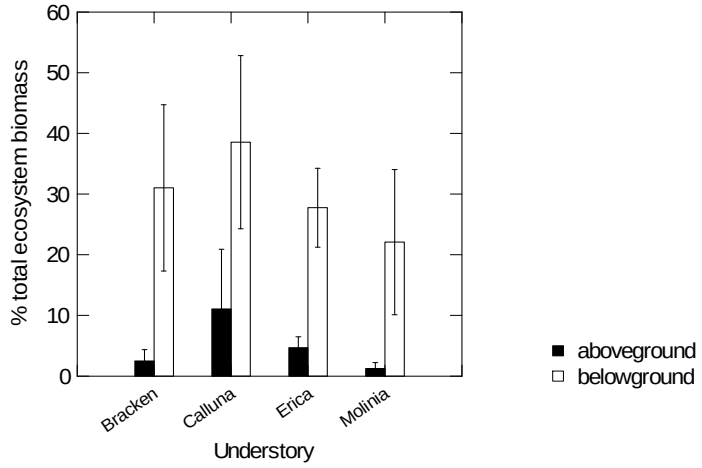

Figure 1. Percentage of total ecosystem biomass for the aboveground (filled bars) and the belowground part (open bars) represented by the dominant understory species.

Root/Shoot ratios recorded were on average 0.34 for *Pinus pinaster*, 3.15 for *Erica cinerea*, 3.25 for *Calluna vulgaris*, 8.36 for *Pteridium aquilinum* and 9.49 for *Molinia caerulea*. These results confirm the importance of taking into account both above and belowground compartments of understory species for nutrient budgets in those forests. Allometric relationships were found between phytovolume (combine mean height with cover of the understory dominant species) and aerial biomass for all the four understory species but also with belowground biomass for Bracken and Molinia but not for Ericaceous species (Erica and Calluna). For the Ericaceous species in particular a more precise knowledge of nature and dates of management practices could improve the understanding of understory biomass repartition (Porté et al. 2009). Our results effectively show that phytovolume for *Calluna vulgaris* is correlated to the mean age of the understory species which must be directly dependent on the date of the last management action. Combined with data on nutrient concentrations in the aboveground and belowground biomasses of the understory species, the allometric relationship will be helpful to derive tools for estimating carbon and nutrient pools in the understory vegetation from easily accessible variables.

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