Do invasive grasses employ different water use and rooting strategies than a native chaparral shrub?

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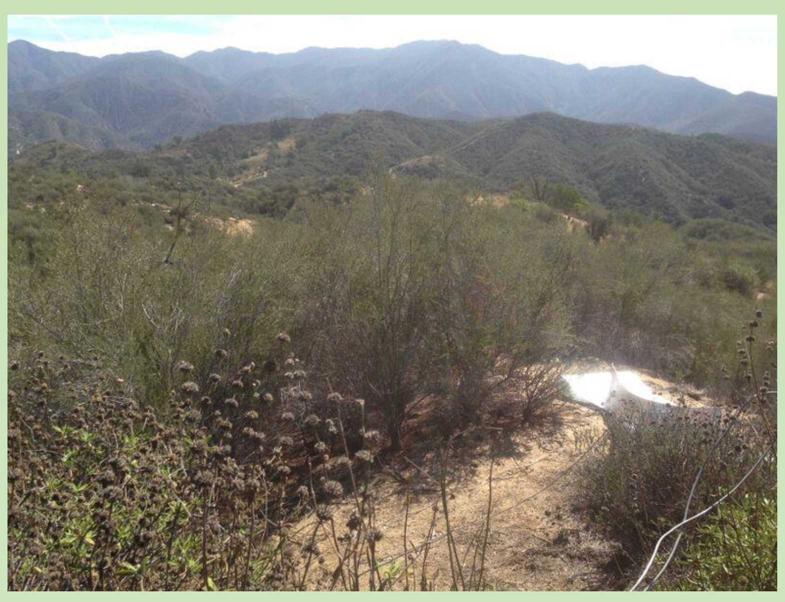
Introduction

- Successful invasion of terrestrial ecosystems by exotic annual grasses causes a shift in community and ecosystem processes.
- The mechanisms promoting and maintaining type conversion are still being uncovered.
- One highly underrepresented avenue of study is the role of belowground phenology for ecosystem function of native and invasive communities. In recent years, research in invasion ecology has utilized both phenological[1] and belowground[2,3,4] approaches, yet there has been a lack of an integrative approach between the two.

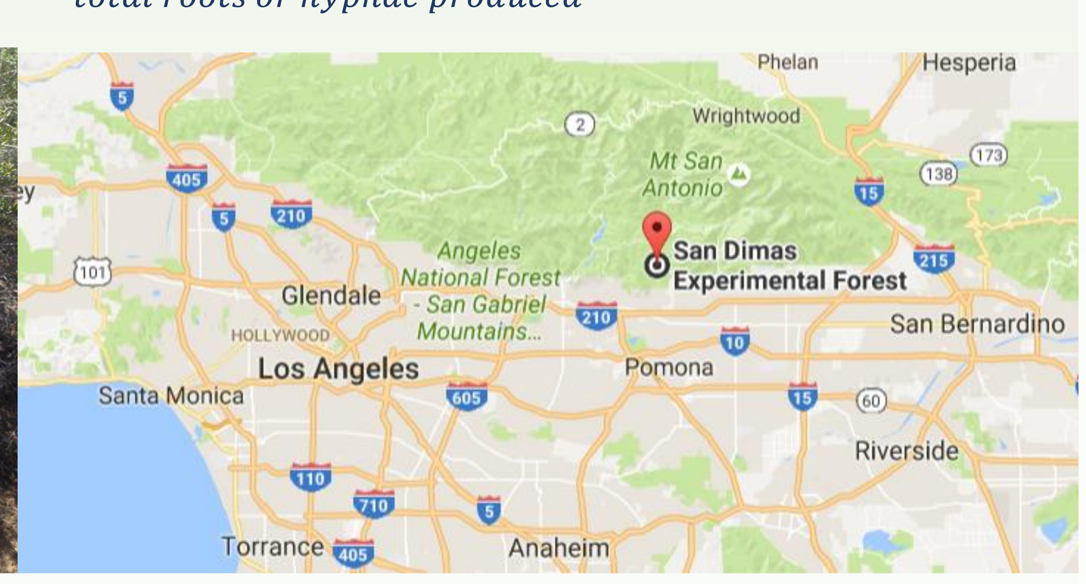


We investigated soil water status as well as root and hyphal abundances of a native chaparral shrub and an invasive perennial grass.

Methods

- The study was conducted in the San Gabriel Mountains at San Dimas Experimental Forest (50 km east of Los Angeles) at 830 meters.
- The forest consists primarily of chaparral shrubland, but some areas were deliberately type converted to grassland during the 1960s.
- Sensor networks were deployed in a paired plot design, with one stand of chaparral (*Adenostoma fasciculatum*) and another stand of invasive grasses (*Ehrharta calycina).*
- In the grass stand, we set up six paired plots, consisting of three 1x1m sub-plots with grass vegetation left intact and three 1x1m sub-plots with grass vegetation removed.
- Within the grass and chaparral stands, we deployed VWC (volumetric water content) and temperature sensors (CS-650, Campbell Scientific Inc.) at 30cm depth.
- We monitored seasonality of root and hyphal production using a manual minirhizotron camera (MMR, Rhizosystems, LLC), a wireless 100x digital camera that runs through a transparent tube buried in the soil.
- One transparent minirhizotron tube (100 cm long, 5 cm diameter) was installed in each location, for a total of 3 tubes in each vegetation type.
- Imagery was taken weekly or bi-weekly from October 2015 until May 2016.
- We recorded eighty to one hundred 12mm x 9mm images for each tube at every time step that are then organized into a mosaic using Rootview (Rhizosystems, LLC).
- Roots and hyphal densities were calculated by:

$$\text{Root or hyphal density} = \frac{\text{roots or hyphae at } x}{\text{total roots or hyphae produced}}$$



Results

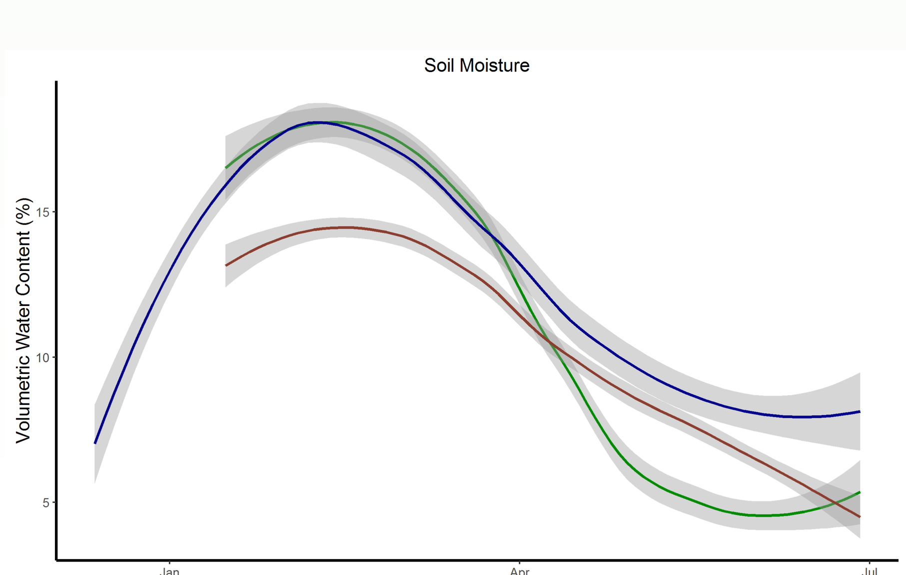


Figure 1: Linear model fit to volumetric water content data at 30cm depth of *A. fasciculatum* (blue; n=3), *E. calycina* (green; n=3) and bare (brown; n=3) plots. Grey shading represents standard error.

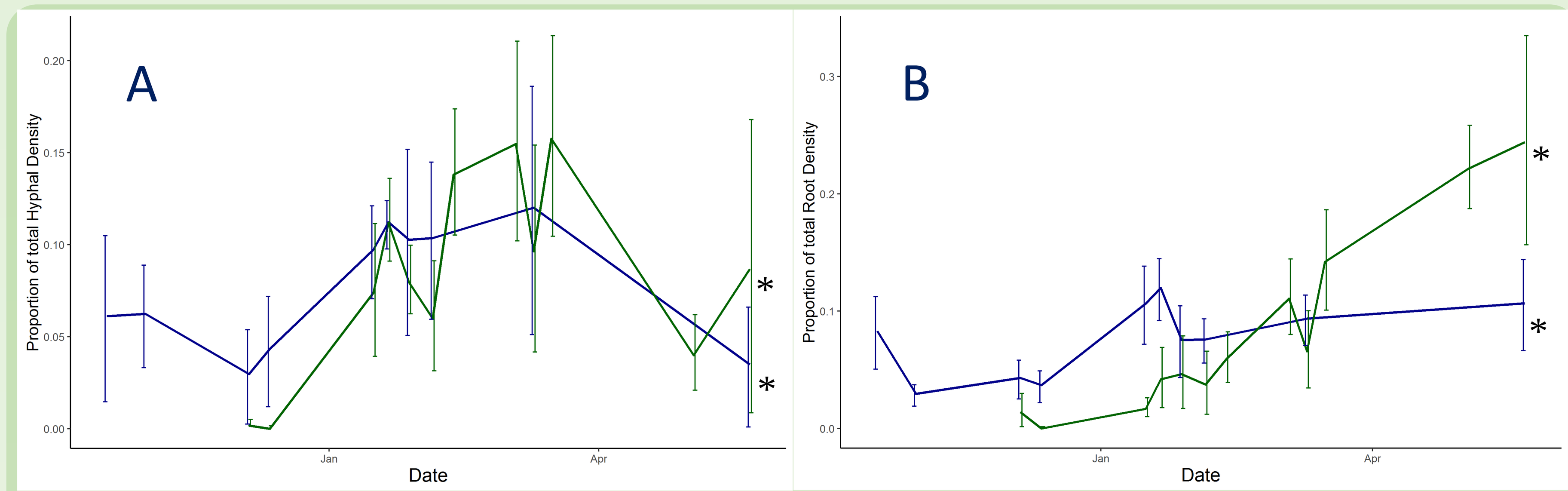


Figure 2: Proportion of total hyphal (A) and root (B) abundance (n=3) of *Adenostoma fasciculatum* (blue) and *Ehrharta calycina* (green) from October 2015 until May 2016. Asterisks indicate significant difference at α=0.05 of vegetation type and time.

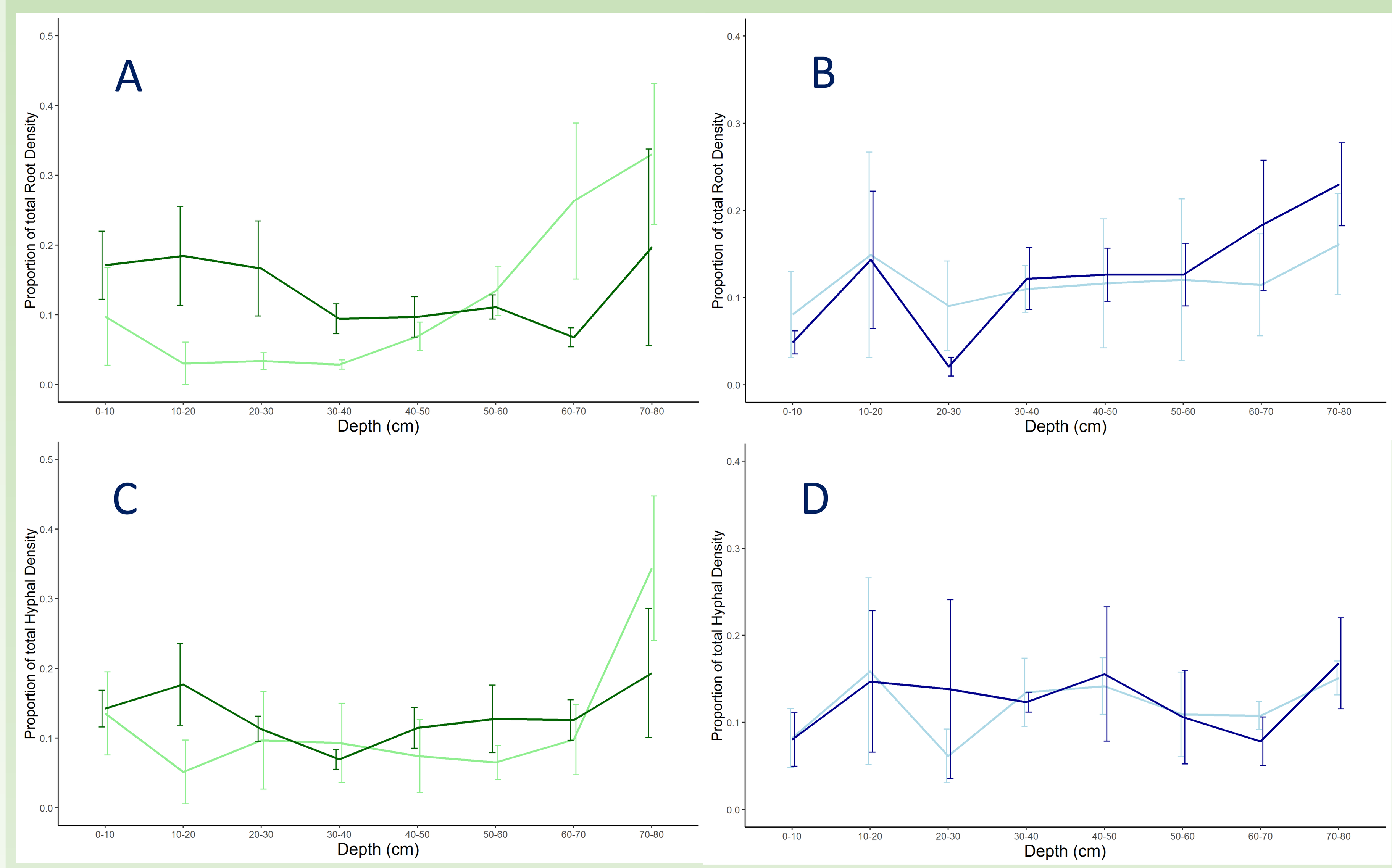


Figure 3: Proportion of total root (A and B; n=3) and hyphal abundance (C and D; n=3) by depth of *E. calycina* (green) and *A. fasciculatum* (blue) divided into early growing season (light blue and green; Dec-Feb) and late growing season (dark blue and green; Mar-May).

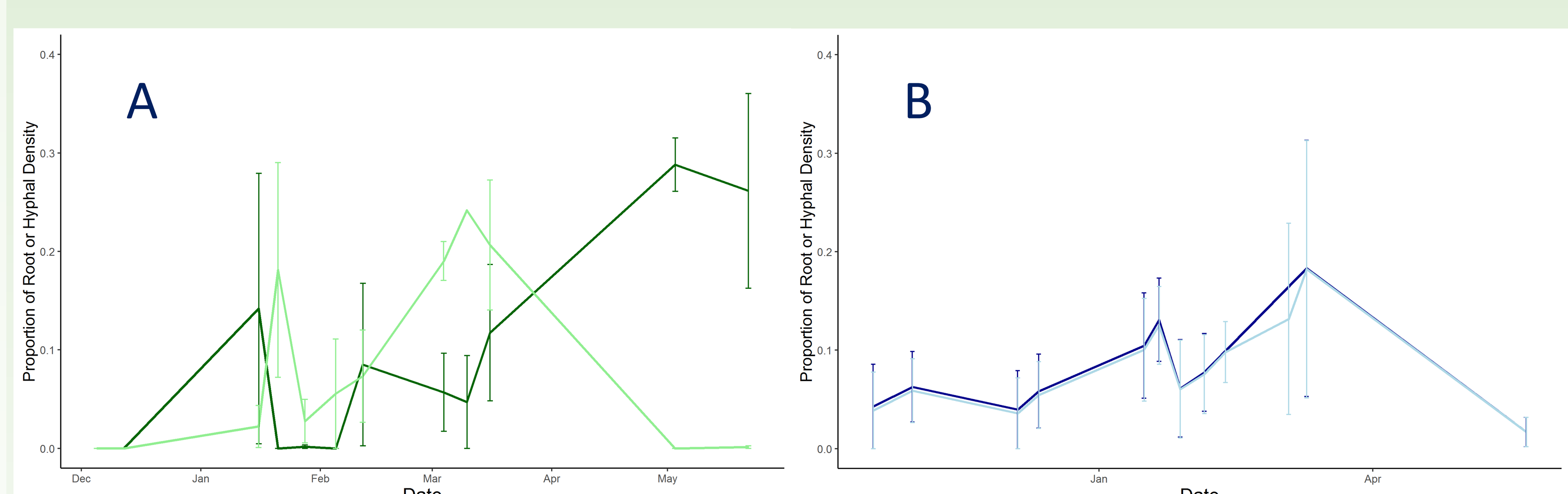


Figure 4: Root (dark blue and green) and hyphal (light blue and green) densities at 25-35cm *A. fasciculatum* (B) and *E. calycina* (A) .

Conclusions

- *E. calycina* depleted soil moisture more rapidly than *A. fasciculatum* and areas with no vegetation starting in April.
- *E. calycina* had greater root production than *A. fasciculatum* later in growing season.
- Earlier soil dry-down may be linked to the upregulation of root production in *E. calycina*.
- Root and soil moisture (at 30cm) appear to be coupled for *A. fasciculatum*, but soil moisture appears to decrease as root density increases for *E. calycina.*
- Both species produce the majority of their roots between 70-80cm, which may lend to greater competition in a mixed stand.
- Hyphal abundance appears to be coupled with root abundance (at 25-35cm) for *A. fasciculatum* throughout the growing season and decoupled for *E. calycina* as the growing season progresses. This may mean that mycorrhizae associated with *E. calycina* have shorter lifespans than those associated with *A. fasciculatum*. *A. fasciculatum* may posses mycorrhizae with longer lifespans to aid in resource acquisition during the summer drought. Differences in mycorrhizal associations may lead to a decrease in native inoculum with increased invasion.
- Greater soil moisture extraction by the grass coupled with higher rooting density are likely to reduce the ability of the native shrub to recover.

Acknowledgements

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References

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