Exotic and Native Forbs: Plant Productivity, Soil Respiration, and Soil Nitrogen

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We compared biomass production, respiration, and soil nitrogen in native and invasive forb monocultures after one year of growth. We did not observe consistent differences among invader and native species as a group, but we did detect differences at the species level.

Kyle estimates biomass volume in a leafy spurge monoculture.

Invasive plants, such as spotted knapweed, outcompete native plants and reduce diversity at a local scale. Invaded areas often show increased plant growth and soil nitrogen. These differences may stem from comparing a grass to a forb, or a monoculture to a mixed plot, rather than ***direct*** effects of invasion. To look at direct and indirect effects of forb invasion, we established a grid of native and exotic plots in spring 2013. Plots contain monocultures of a single species, an even mixtures of species, or mixtures with one dominant species.

In collaboration with the Ecology Project International's Bitterroot Wildlife Internship program, we explored differences in planted exotic and native forb monocultures. Target species included sticky cinquefoil *(Drymocallis glandulosa)*, golden aster *(Heterotheca villosa)*, yarrow *(Achillea millefolium)*, sulfur cinquefoil *(Potentilla recta)*, knapweed *(Centaurea stoebe)*, and leafy spurge *(Euphorbia esula)*. We investigated plant growth, carbon allocation, and nutrient cycling with measures of soil moisture, temperature, respiration, inorganic nitrogen, and aboveground biomass at 48 unique plots.

Plant Biomass and Soil Respiration

Based on evidence from field studies, we expected invaders to have higher biomass volume than natives. Two of the invaders, knapweed and leafy spurge, produced significantly greater biomass than native species (fig 1).

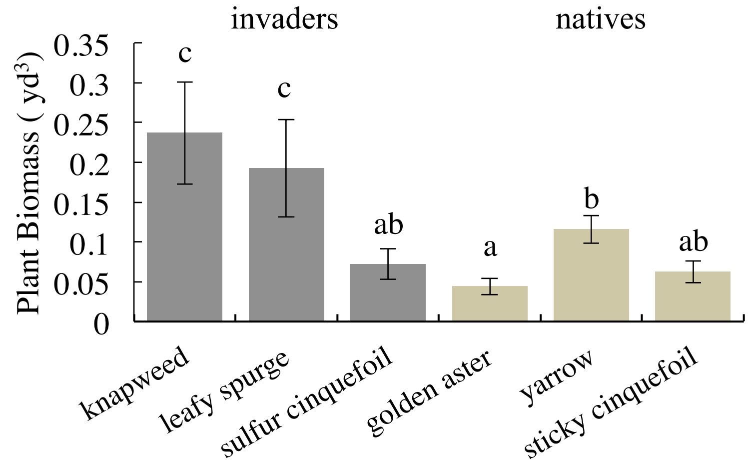


Figure 1. Aboveground plant biomass (± standard error) of forb monocultures. Letters indicate significant differences in means (α=0.05).

Aboveground biomass production may be connected to belowground carbon allocation. We expected invaders to exhibit higher soil respiration than natives. Two invaders, knapweed and leafy spurge, exhibited higher soil respiration than native species (fig 2).

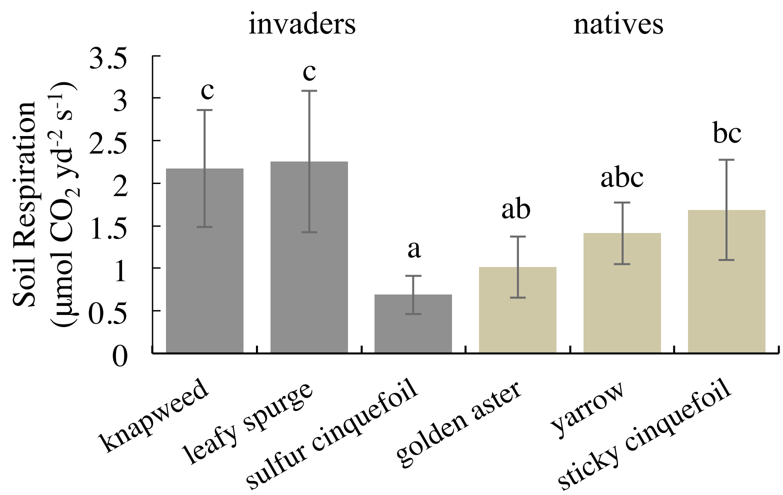


Figure 2. Soil respiration (± standard error) of forb monocultures. Letters indicate significant differences in means (α=0.05).

We detected no differences among species for soil moisture or temperature.

We expected species with higher biomass to also exhibit greater soil respiration (fig 3). Exceptions to this trend, golden aster and sticky cinquefoil, had high ratios of soil respiration to plant biomass. This may indicate greater carbon allocation belowground.

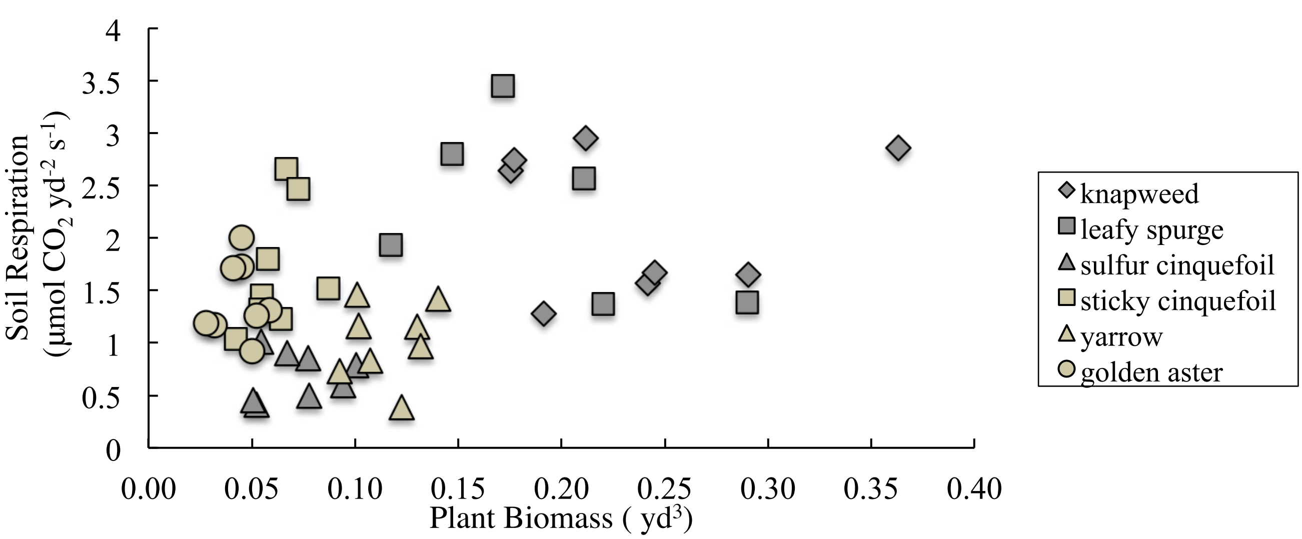


Figure 3. Plant biomass and soil respiration show a weak, positive correlation (R^2=0.17). Golden aster (tan circles) and sticky cinquefoil (tan squares) did not follow trend.

Soil Nitrogen

Based on previous field and experimental studies we expected higher amounts of soil nitrogen, measured here as ammonium (NH_4^+) and nitrate (NO_3^-), in invaded soil. We only detected higher soil NH_4^+ in a single invader, sulfur cinquefoil (fig 4). We measured lower soil NO_3^- in a single native, sticky cinquefoil (fig 5).

We did not detect a relationship between biomass production and elevated NH_4^+ and NO_3^- levels in the soil.

In time, we expect the forb monocultures to exhibit differences in respiration and nitrogen cycling due to development of species specific plant-soil feedbacks.

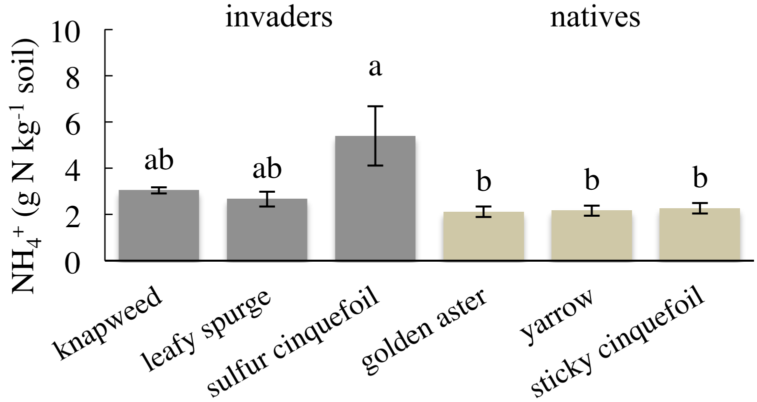


Figure 4. Soil ammonium (NH_4^+) means (± standard error) for all plots. Letters indicate significant differences in means (α=0.05)

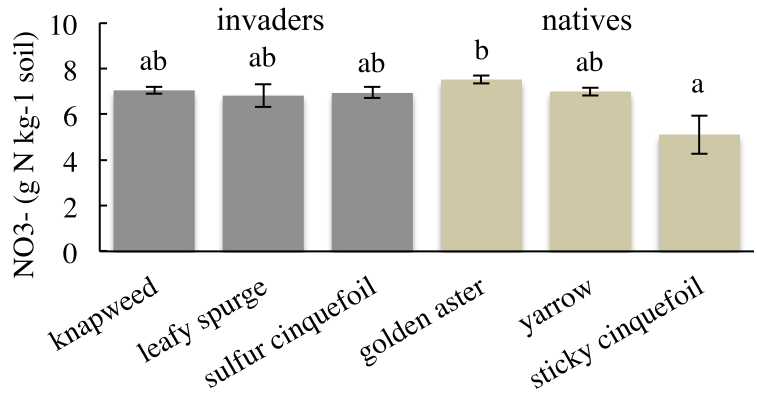
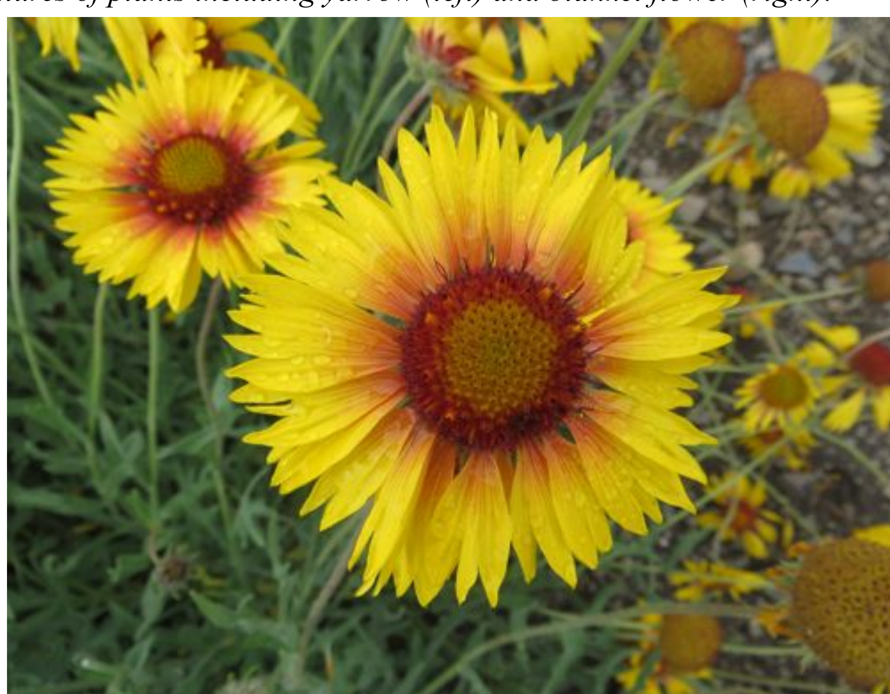


Figure 5. Soil nitrate (NO_3^-) means (± standard error) for all plots. Letters indicate significant differences in means (α=0.05)

The experimental plots contain monocultures of plants including yarrow (left) and blanket flower (right).



Experimental plot aboveground standing biomass peaks during mid-June.