**Title: Functional traits help explain plant demographic responses to abiotic and biotic environmental variation**

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**Background/Question/Methods**

An central aim in ecology is to explain community turnover across space and to predict species demography over environmental gradients. Although variation in community-weighted functional traits along gradients is a well-documented pattern, we lack a clear understanding of how plant functional traits can help predict species’ abundance and demography in heterogeneous landscapes. We conducted a field experiment in an annual plant community in coastal California to ask whether functional traits can help explain variation in species’ demographic responses to environmental variation. Specifically, we estimated germination rate, per-capita seed production in the absence of competitors, and sensitivity to competition of seventeen annual plant species across twenty four sites. We measured air temperature, soil texture, micro- and macro-nutrients, and soil water content at various times during the growing season, and additionally characterized the soil microbial community at each site using metagenomic sequencing of the bacterial 16S, fungal ITS, and eukaryotic 18S regions. We then tested whether leaf, root, seed, and whole-plant functional traits help explain species demographic response to these environmental characteristics.

**Results/Conclusions**

The abiotic variation among our sites was substantial and was primarily driven by soil chemistry, texture, and depth. There was also significant turnover in soil microbial communities among the sites, which was not explained well by the environment alone. Plant species varied in their demographic response to these abiotic and biotic environmental axes- for example, soil texture was the strongest univariate environmental driver of low-density seed production for eight species, but it was a poor predictor of seed production for the remaining species. Key plant functional traits, such as specific leaf area, flowering phenology, and seed size help explain variation in the three demographic responses; for example, smaller seeded species tended to achieve higher germination rates in sandier soils. Our results highlight the value of experimentally linking plant functional traits to their environmental responses to improve our understanding of how species traits mediate community assembly across environmental gradients.