Deconvolving Local versus Regional Controls over Plant and Ecosystem Responses to Climate Change in Pacific Northwest Prairies

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Climate change is likely to shift plant range distributions and result in novel community assemblages. In turn, changes in plant community structure and ecosystem function, in particular carbon and nutrient cycling, may be closely intertwined. Furthermore, past manipulative climate change studies that have examined these issues have largely been done at a single site, and it is unclear to what extent such findings are regionally consistent.

We used a manipulative climate change experiment (increased temperature and precipitation) embedded within a 520 km natural climate gradient in the Pacific Northwest (PNW) to examine (1) the demographic responses of 12 prairie species with northern range-limits within the PNW, (2) shifts in plant community composition, and (3) carbon and nutrient cycling at three restored upland prairies for three years. For the 12 species, warming decreased the net reproductive rate, largely through a decrease in recruitment, even at the coolest edge of their current ranges, but this effect disappeared when they were moved poleward beyond their current ranges. These results are consistent with predictions that many species will need to expand their ranges poleward to successfully maintain viable populations. Warmed plots had higher abundance of annuals and introduced species, and became more similar to their southern counterparts over time, suggesting that functional group composition in PNW prairies may become similar to that currently seen in California with predicted changes in climate. Moreover, warming had a consistent positive effect on both above- and belowground NPP over the course of this study, probably due to a coincident increase in nutrient availability. Warming increased annual soil respiration by 28.6% in the northern site, 13.5% in the central site, and not at all in the southern site, reflecting the increasing degree of drought limitation from north to south in the Mediterranean climate of the PNW. Increased precipitation during the rainy season did little to alleviate drought stress and had minimal effects on range-limits, community composition, or carbon and nutrient cycling. Our results suggest that conservation planners need to (1) consider shifting species distributions and the potential need for assisted relocation with future climate change and (2) rethink the intensity of management needed to maintain native species and/or reassess feasible targets for restoration quality. The effect of warming on ecosystem processes appears to be strongly constrained by seasonal drought in these Mediterranean-climate ecosystems. Finally, our experiment demonstrates the strength of embedding manipulative climate experiments within regional climate gradients.