Climate change and C_4 and C_3 grasses in a midlatitude dryland steppe

Robert Anderson[1], Trace Martyn[1], Rachel Renne[1], Ingrid Burke[1], and William Lauenroth[1]

[1]Yale University School of the Environment

April 19, 2024

Abstract

Climate change is projected to alter the structure of plant communities due to increasing temperatures and changes to precipitation patterns, particularly in midlatitude dryland ecosystems. Modifications to climatic suitability may lead to major community changes such as altered dominant plant functional types. Previous studies have indicated that climatic suitability is likely to increase for C4 grasses and decrease for C3 grasses in the western United States. However, if no C4 grass species currently exist to serve as a propagule source, expansion into areas of increased suitability will be limited. We conducted a field and modeling study in the Upper Green River Basin (UGRB) of western Wyoming to determine if 1) C4 grasses are present to provide a propagule source and 2) C4 grasses are likely to increase in importance relative to C3 grasses due to climatic changes. We searched 44 sites for C4 grasses to establish presence, and modeled suitability at 35 sites using 17 Global Climate Models, two greenhouse gas Representative Concentration Pathways (RCPs; 4.5 and 8.5), and two time-periods (mid- and late-century; 2030-2060 and 2070-2099, respectively). We found C4 grasses at 10 of the 44 sites, indicating that there is a present propagule source. Our model projected increases in suitability for both C3 and C4 grasses across sites for all RCPs and time-periods. In the mid-century RCP 4.5 scenario, the C3 functional type increased in projected biomass in 29 of 35 sites, and the C4 type increased in 31 sites. In this scenario, C3 grasses increased in projected biomass by a median 4 gm-2 (5% change), and C4 grass biomass increased by a median 8 gm-2 (21% change). Our study suggests that climate change will increase climatic suitability for grasses across the UGRB, and that all requirements are in place for C4 grasses to increase in abundance.

Hosted file

`E_and_E_Main_Submission.docx` available at https://authorea.com/users/772035/articles/856553-climate-change-and-c4-and-c3-grasses-in-a-midlatitude-dryland-steppe