

Throop, HL, LG Reichman, OE Sala, SR Archer. 2011. Response of dominant grass and shrub species to water manipulation: An ecophysiological basis for shrub invasion in a Chihuahuan Desert Grassland. *Oecologia* (In Press)

Increases in woody vegetation and subsequent declines in grasses in arid and semi-arid ecosystems have occurred globally since the 1800s, but the mechanisms driving this major land-cover change remain uncertain and controversial. Working in a shrub-encroached grassland in the northern Chihuahuan Desert where grasses and shrubs typically differ in leaf-level nitrogen allocation, photosynthetic pathway, and root distribution, we asked if differences in leaf-level ecophysiology could help explain grass displacement. We predicted that the relative performance of grasses and shrubs would vary with soil moisture due to different morphological and physiological characteristics of the two life-forms. In a 2-yr experiment with ambient, reduced, and enhanced precipitation during the hot monsoon season, the encroaching C₃ shrub (honey mesquite, *Prosopis glandulosa*) consistently and substantially outperformed the historically-dominant C₄ grass (black grama, *Bouteloua eriopoda*) with respect to photosynthetic rates while also maintaining a more favorable leaf water status. These differences persisted across a wide range of soil moisture conditions, across which mesquite photosynthesis was decoupled from leaf water status and moisture in the upper 50 cm of the soil profile. Mesquite's ability to maintain physiologically active leaves longer in the growing season than black grama potentially amplifies and extends the importance of physiological differences. These substantial physiological and phenological differences help account for grass displacement by shrubs in drylands. Furthermore, greater sensitivity of the grass to low soil moisture suggests that present-day grasslands may be increasingly susceptible to shrub encroachment in the face of predicted increases in droughts in the desert southwestern United States.