
GPE publication 2014-15

# Climate warming and precipitation redistribution

A summary of Astrid Volder, David D. Briske and Mark G. Tjoelker, 2013.[1]

*by Sherry Middlemis-Brown*

## INTRODUCTION

Openness of landscape, wide growth of old oak trees and interplay of colors and light make oak savanna a pleasing combination of trees and grass. Oak savannas provide important habitat for plant and animal species adapted to this distinct, but rare ecosystem. Historically, oak savanna sustained bison and elk, but now it also plays a role in cattle production in some parts of the country.

Grasslands and savannas within the Great Plains will likely experience some combination of rising temperature and altered precipitation associated with climate change. The precipitation changes may shift the number of large storms and their timing, resulting in periods of severe storms and summer drought. Understanding potential shifts in plant survival and growth rate caused by climate change will help us to speculate possible impacts to southern oak savannas.

Volder, et al. (2012) found that tree—grass interactions in southern oak savannas may respond to climate change. In a remnant post oak (*Quercus stellata*) savanna near College Station, Texas, the investigators replicated conditions that could result from climate change by controlling temperature and moisture (precipitation) in a climate-control structure. For six years, the investigators altered precipitation and atmospheric temperature and examined responses of post oak, eastern redcedar (*Juniperus virginiana*), and little bluestem (*Schizachyrium scoparium*) to climate conditions, and they observed each tree's responses in association with little bluestem grass understory. They planted five species combinations within the climate-control structure, and subjected each combination to two precipitation and two warming scenarios, resulting in 20 treatment combinations.

## EFFECTS OF CONDITION COMBINATIONS

**Precipitation:** Climate change models suggest that precipitation may occur in spring and autumn with fewer summer events than historically recorded. Within the experiment, this redistribution of precipitation resulted in reduction of growth rate among both post oak and eastern redcedar. Little bluestem adapted to the change and produced as many tillers under the climate scenarios, although the number of reproductive tillers declined.

All three species demonstrated drought tolerance, although eastern redcedar demonstrated greater tolerance than did post oak. Drought reduced the number of tillers among the little bluestem.


*Little bluestem*
© Oaksavannas.org

**Warming:** An increase in temperature increased the survival and growth rate of eastern redcedar, when precipitation remained at historical levels. Warming decreased post oak survival, but did not affect growth rate. Grass seemed unaffected by increases in average temperature.

**Warming with intensified drought:** This combination might have implications for the persistence of southern oak savannas. Eastern redcedar had no change in survival or above ground mass under the combined conditions. In contrast, both post oak and little bluestem suffered adverse impacts from the heat-drought combination. Little bluestem produced fewer reproductive tillers in this scenario, which would affect long-term species survival.

Although investigators did not grow the two tree species together, the investigators grew each of the tree species in combination with little bluestem. Grass suppressed young trees of both species, but once established trees reached over 40 inches in height, tree—grass interactions changed, based on the tree species present. Presence of grass did not affect eastern redcedar survival and growth, and it had a positive effect on survival and growth rates for post oak. Eastern redcedar adversely affected survival and tiller numbers of little bluestem. Post oak had no impact on little bluestem, creating a neutral or beneficial association between post oak and grass.

## IMPLICATIONS FOR SOUTHERN OAK SAVANNAS

Eastern redcedar, an invasive species in savannas, glades, and grasslands, tolerates both heat and drought conditions. Little bluestem seemed to tolerate extreme conditions, but heat and drought reduced production of tillers, including reproductive tillers. This grass species will not remain competitive in warm temperatures and intensive drought. Post oak will also lose ground in these extreme conditions, even when growing with little bluestem. These findings suggest that climate change, resulting in summer heat and drought, will give eastern redcedar a competitive advantage over the oak savanna community.

Not only will climate change directly affect oak savannas, but the reduction in post oak or little bluestem will create opportunity for eastern redcedar invasion. The competitive advantage of eastern redcedar in a changed climate could intensify its invasiveness and increase encroachment in savannas. Mature eastern redcedars can reduce grass cover under each tree, reducing the fine fuels needed to attain sufficient fire intensity that will kill mature eastern redcedar trees (Twidwell, et al. 2013).* Therefore, land managers will find prescribed fire less than effective in controlling eastern redcedar in this changed environment.

Volder, et al. did not investigate the eastern redcedar—post oak competition, but identified other studies that found eastern redcedar to outcompete oaks in the absence of intense fire. Twidwell, et al. (2013) helps us to understand the mechanism for this interaction. This information supports frequent use of fire in restoring and maintaining southern oak savannas before eastern redcedar matures and affects fine fuel levels.

**Dirac Twidwell, Samuel D. Fuhlendorf, Charles A. Taylor Jr., and William E. Roger. 2013. Refining thresholds in coupled fire–vegetation models to improve management of encroaching woody plants in grasslands. Journal of Applied Ecology 50:603-613. The GPE has a summary of this paper available on their website, http://GPFireScience.org.*


*Example of 14-year-old oak savanna (not test plots in this study). Little bluestem grows in association with oaks. This association appears to be beneficial to oaks.*

A summary of the interactions represented by the 20 experimental combinations tested.

| CONDITIONS | EFFECTS ON EASTERN REDCEDAR | EFFECTS ON POST OAK | EFFECTS ON LITTLE BLUESTEM |
|---|---|---|---|
| **Precipitation—distribution change and drought** | Reduced growth rate; tolerant of drought | Reduced growth rate; less tolerant of drought than eastern redcedar | Grass tolerated distribution change, but with decreased reproductive tillers; drought reduced tiller production |
| **Warming—without precipitation change** | Increased survival and growth rate | Decreased survival, but did not affect growth rate | No effect |
| **Warming + intensified drought** | Did not affect survival and above ground mass | Adversely affected growth and survival | Adversely affected, including reproduction, causing long-term effects |
| **Presence of little bluestem** | Suppressed young trees, but did not affect established trees; eastern redcedar suppressed grass growth and survival | Suppressed young trees, but improved established tree survival and growth rate; trees did not affect grass | Grass survival in the grass monoculture remained similar to that for the grass-oak association. |
| **Established eastern redcedar** | No tree interactions were tested | | Reduced tillers and reduced survival |
| **Established post oak** | | | No effect on grass |

[1] *Astrid Volder , David D. Briske and Mark G. Tjoelker. 2012. Climate warming and precipitation redistribution modify tree–grass interactions and tree species establishment in a warm-temperate savanna. Global Change Biology (2012), doi: 10.1111/geb.12068. Blackwell Publishing Ltd.*

*The Great Plains Fire Science Exchange has resources on fire, fire effects, monitoring, and more at http://GPFireScience.org.*

For more information:

http://GPFireScience.org Email: GPFireScience@missouristate.edu

Sherry Leis, Program Leader

Carol Blocksome, Outreach specialist