Warming and Rainfall Manipulation (WaRM) Project: Growth Form Contrasts in Oak Savanna

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Rationale / Approach

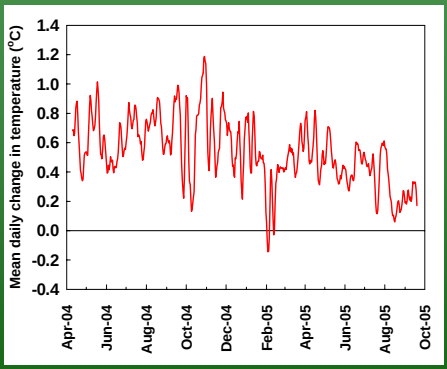
- Mechanistically evaluate leaf and root trait responses to warming and rainfall redistribution

- Establish a physiological basis for the responses of three contrasting growth forms (C_4 grass, C_3 deciduous tree, C_3 evergreen tree) to these global change drivers.

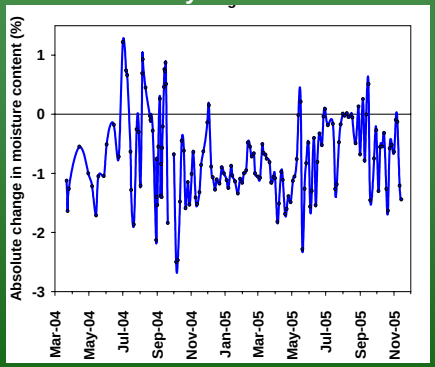
- Explore the potential for warming and rainfall redistribution to modify competition between dominant growth forms of southern oak savanna using mixed species plots.

Warming

Mean soil warming is ~0.5ºC at 3 cm



Warming reduces volumetric soil water content by 1%.



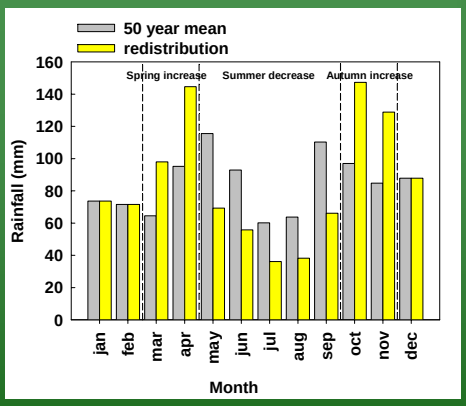
Simulated Rainfall Regimes

I. Long-term mean (50 year)

Simulated from event size and distribution of months that approached mean long-term monthly precipitation.

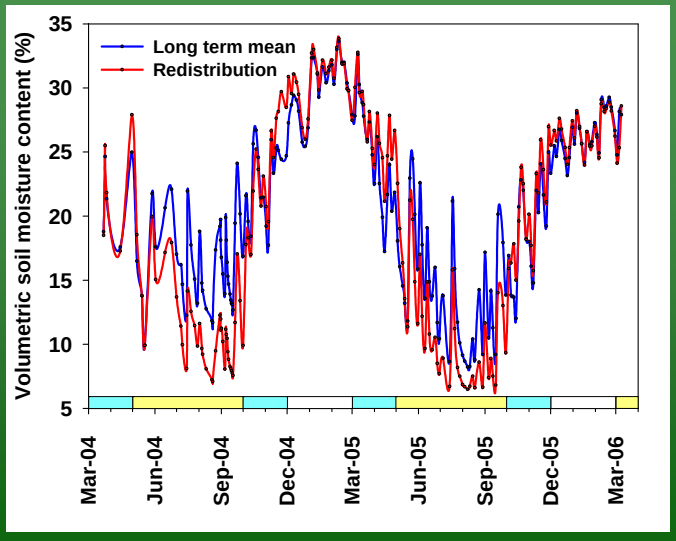
II. Redistribution

Reduce May – September precipitation by 40% and redistribute this amount to spring (March-April) and autumn (October-November)



Total annual precipitation (1018 mm) and the number and frequency of events are identical between the two rainfall regimes.

Volumetric Soil Water Dynamics



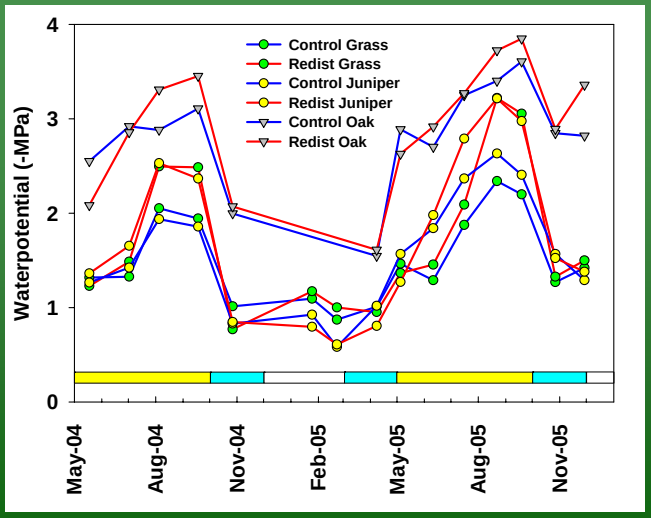
Redistributed plots receive 50% more water

Redistributed plots receive 40% less water

Neutral phase All plots receive equal water

Water potential and A_{max}

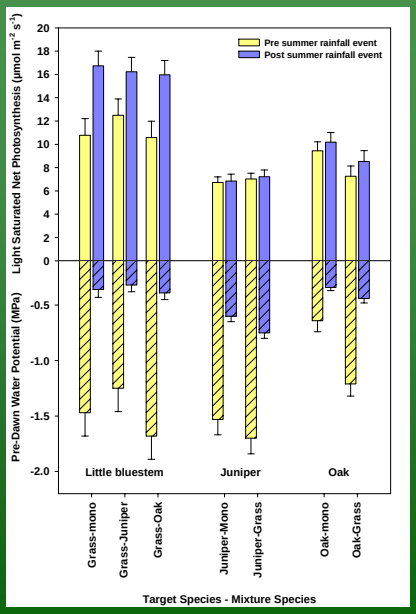
Mid-day Plant Water Potentials



More stress

Less stress

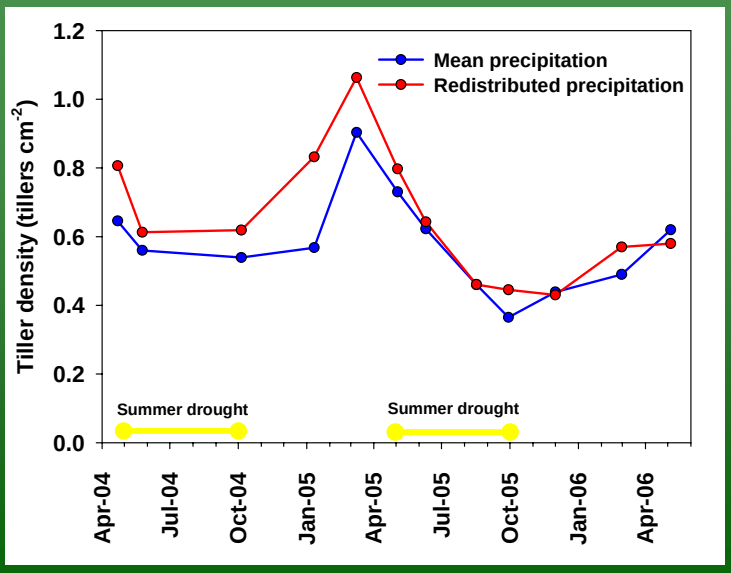
Drought Stress and Recovery



Growth Metrics

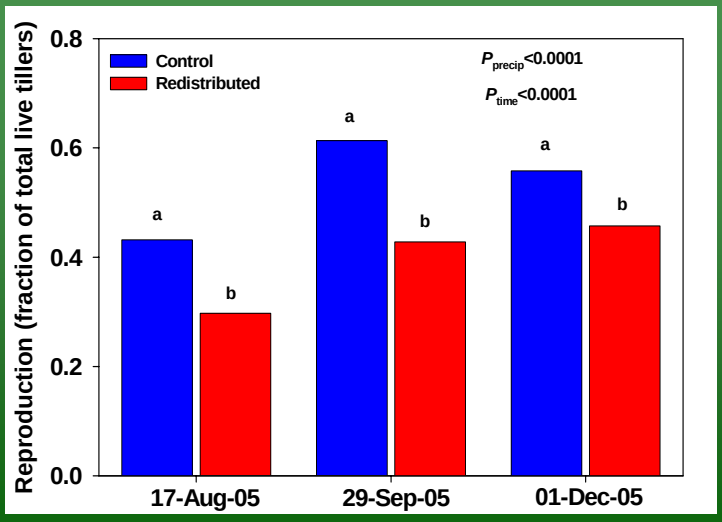
Grass Tiller Density





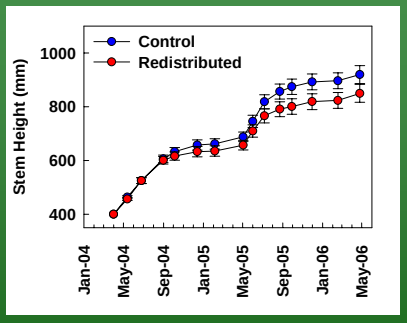
Proportion Reproductive Tillers



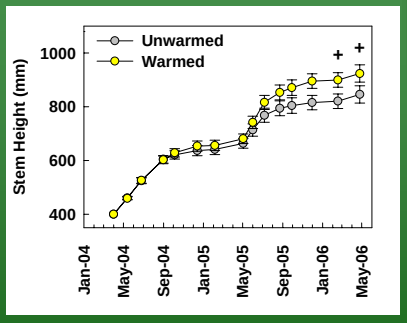


Juniper Height Growth

Rainfall Treatments

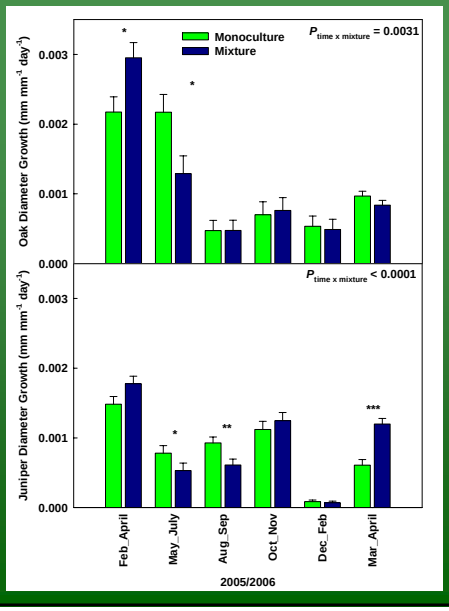


Warming



Species Interactions

Competition-Facilitation Dynamics



Competition-Facilitation Dynamics

	Oak		*Juniper*	
	Cont	**Redist**	**Cont**	**Redist**
Spring (wet phase)	1.42 a	1.39 a	1.30 a	1.14 a
Summer (dry phase)	0.61 b	0.54 b	0.67 b	0.46 b
Autumn (wet phase)	1.67 a	1.14 ab	1.45 a	1.05 ab

Values are ratio's of diameter RGR in mixture and RGR in monoculture in 2005
Values > 1 indicate facilitation by grass presence, values < 1 indicate competition by grass presence, compared to the woody monocultures

Redistribution generally reduces facilitative effects of the grass in spring and autumn, and increases summer competition for water

Conclusions

- Rainfall redistribution decreases soil water content, Ψplant and growth, and A_{max} in the dry summer phase.

- Warming (0.5 ^{o}C soil at 3 cm) induces a modest, but consistent decrease in soil water.

- C_4 grass has greater drought recovery of A_{max} than do trees in the dry summer phase.
- Rainfall redistribution intensifies grass-tree competition in dry summer and reduces grass-tree facilitation in wet autumn phase.

Take Home Message

GC drivers modify competition-facilitation dynamics among trees and grass to mediate responses of oak savanna to GC scenarios.

Acknowledgements

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