

# MANAGING FOR MULTIPLE OUTCOMES ON RANGELANDS— UTILIZING STMs TO DEFINE TRADEOFFS AND SYNERGIES



L.M. Roche, A.T. O'Geen, D.J. Eastburn, K.W. Tate  
University of California, Davis

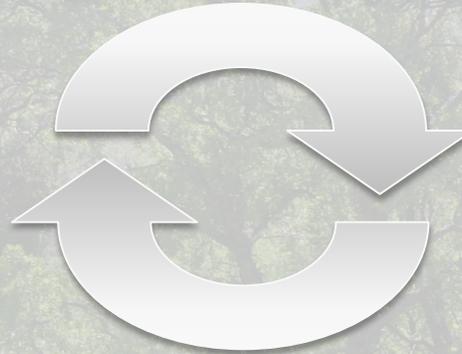


# CALIFORNIA'S HARDWOOD RANGELANDS

~ 10 million acres, largely privately owned



# CALIFORNIA'S HARDWOOD RANGELANDS



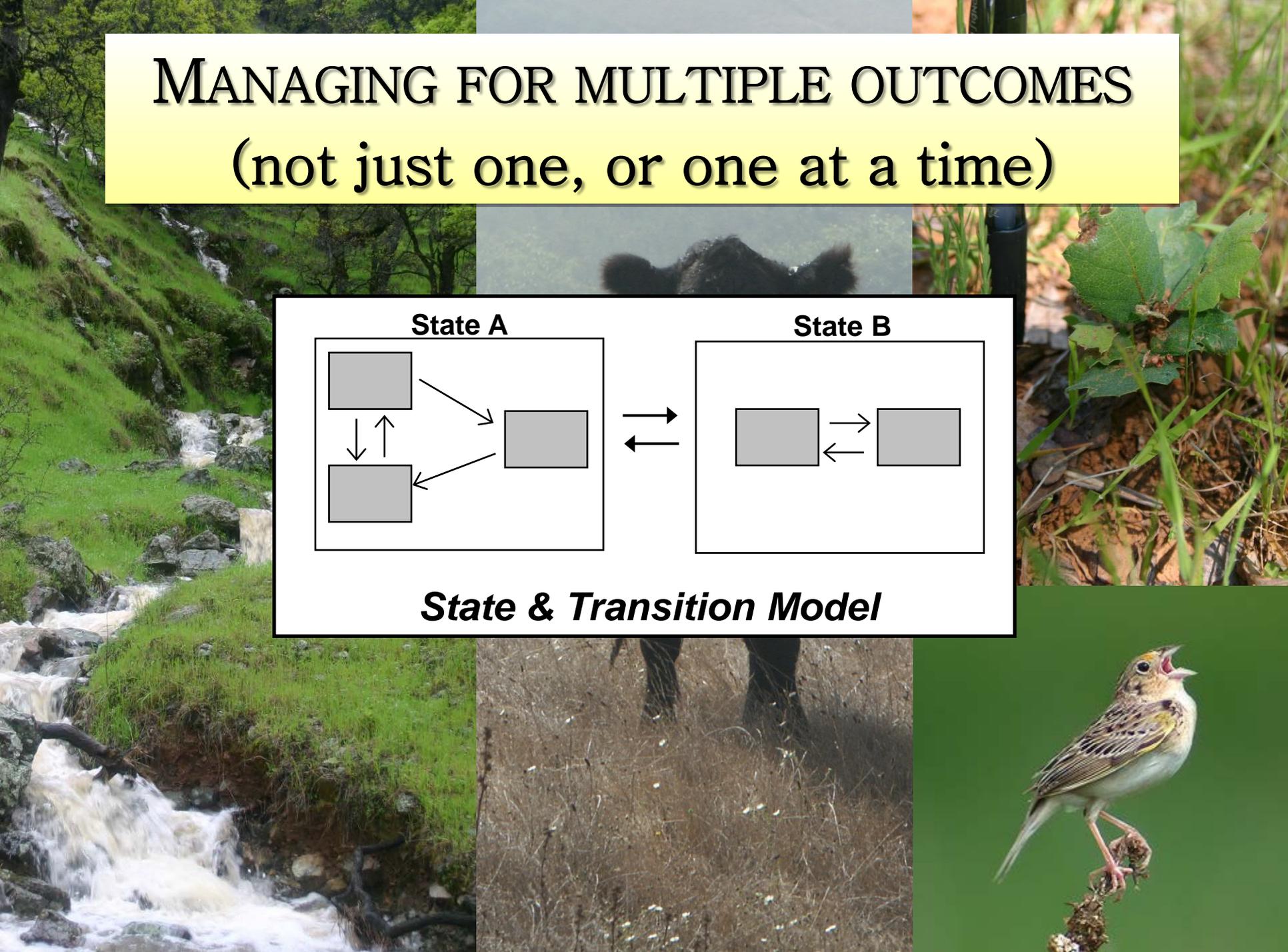
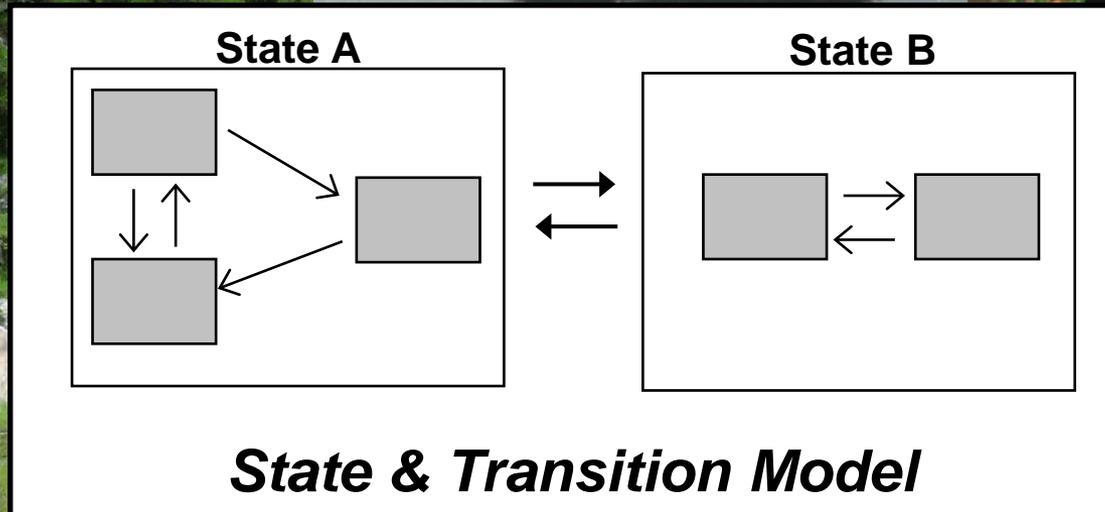
# CALIFORNIA'S HARDWOOD RANGELANDS



**MANAGING FOR MULTIPLE OUTCOMES  
(not just one, or one at a time)**



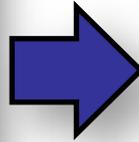
# MANAGING FOR MULTIPLE OUTCOMES (not just one, or one at a time)



# WOODY 'WEEDS' & HOMOGENEOUS GRASSLAND LANDSCAPES

---

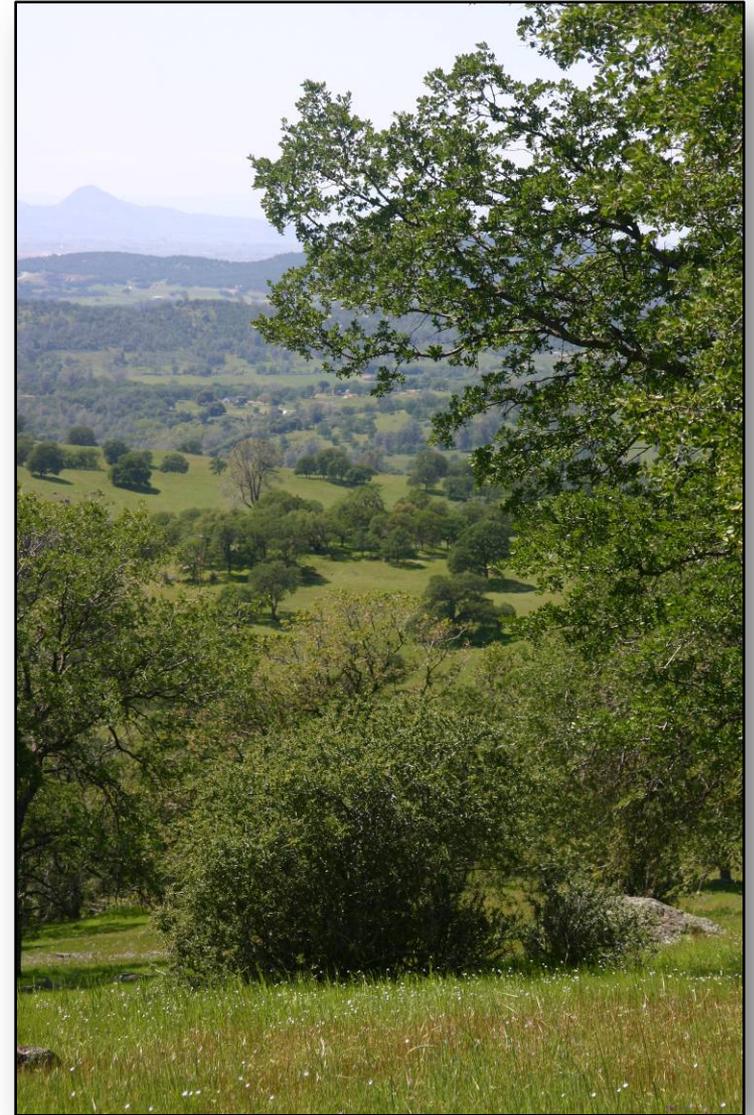
*"Grass, not oaks,  
make your cows fat!"* UCCE 1960s



Brush Management  
*Goal: Forage production*

# SIERRA NEVADA FOOTHILL RANGELAND

---



SFREC Research Station

- 2500ha; 100–600m
- SN Gravelly Loam Foothill ES

# 'Undisturbed' Woodland

Blue Oak / Live Oak / Foothill  
Pine/ Shrubs  
*50-75% Canopy*



Blue Oak / Live Oak / Foothill  
Pine/ Shrubs  
*75-100% Canopy*



## Annual Grassland

*Non-native forb  
dominated*

*Annual grass  
dominated*



*Grasses/forbs,  
Invasives*



**Invaded Grassland**  
*Noxious weed dominated  
(medusahead, goatgrass)*



**Blue Oak  
Savanna**  
*<50% Canopy*

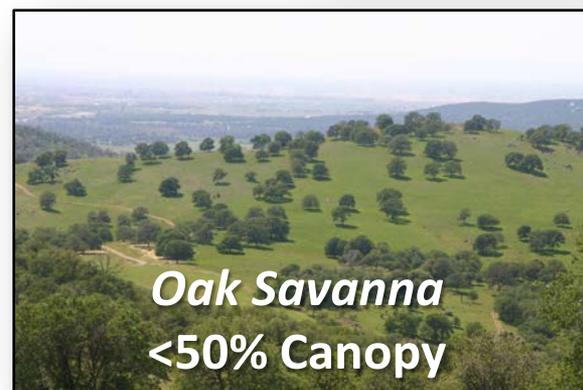
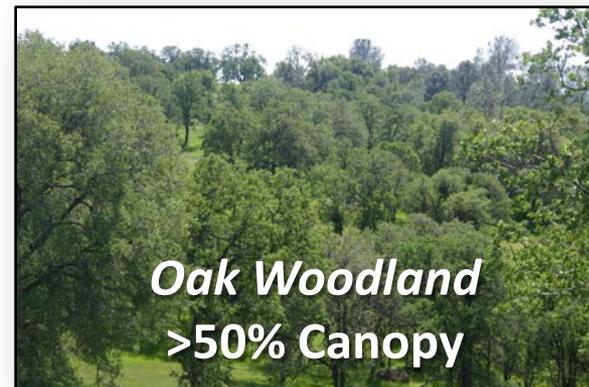
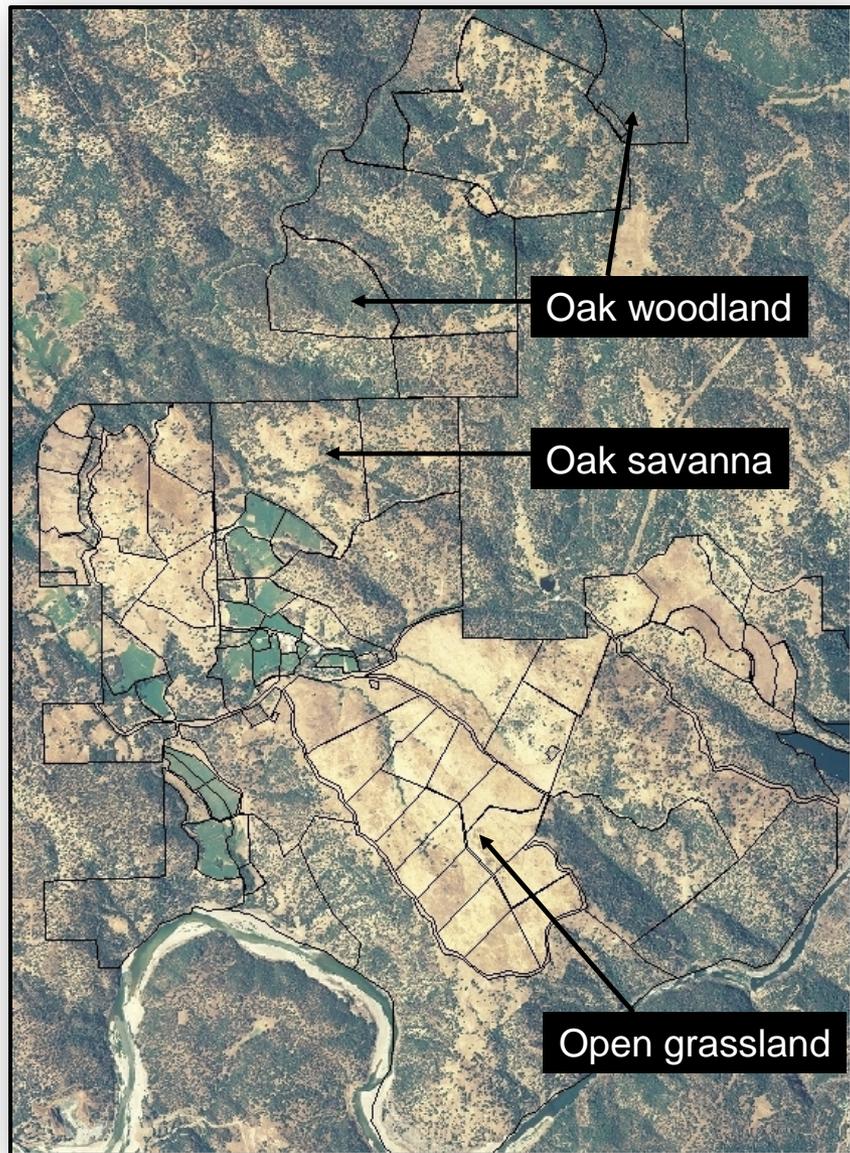


**Shrubland**  
*Annual grass  
dominated*



# SAMPLING DESIGN

---



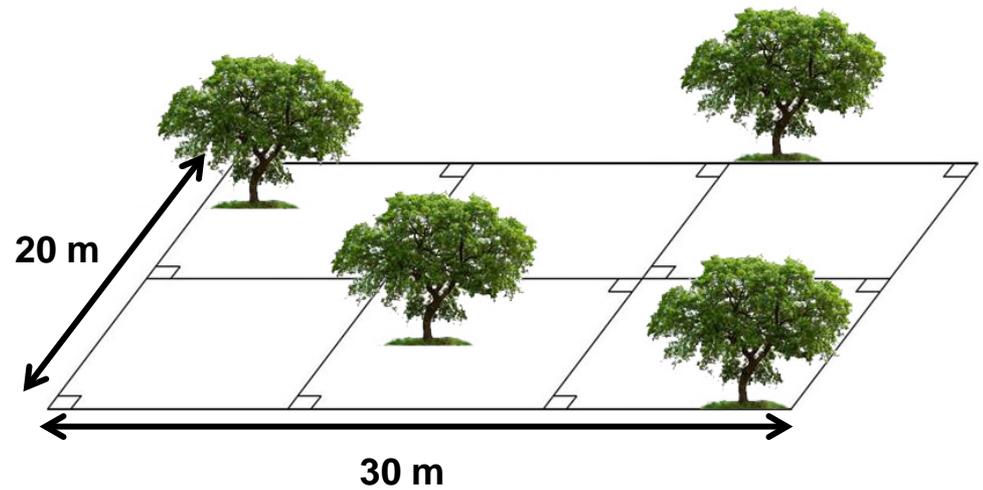
# SAMPLING DESIGN

## Soil and hydrologic properties:

- Profile description
- TC & TN
- Available N & P
- Aggregate stability
- Soil structure
- Bulk density
- Infiltration
- Rupture resistance
- Soil moisture
- Soil temperature

## Plant community properties:

- Composition
- Richness
- Diversity
- Herbaceous Production



1 m

# SIMPLIFIED MODEL

---

***'Undisturbed' Woodland***  
**>50% Canopy**

**Annual grass  
understory**



***Annual Grassland***

**Annual  
grasses/forbs**



***Blue Oak Savanna***  
**<50% Canopy**

**Annual grass dominated  
understory**



# ISLANDS OF FERTILITY

---

***'Undisturbed' Woodland***  
**>50% Canopy**

**46 g TC / kg**  
**3.2 g TN / kg**



***Annual Grassland***

**29 g TC / kg**  
**2.5 g TN / kg**



***Blue Oak Savanna***  
**<50% Canopy**

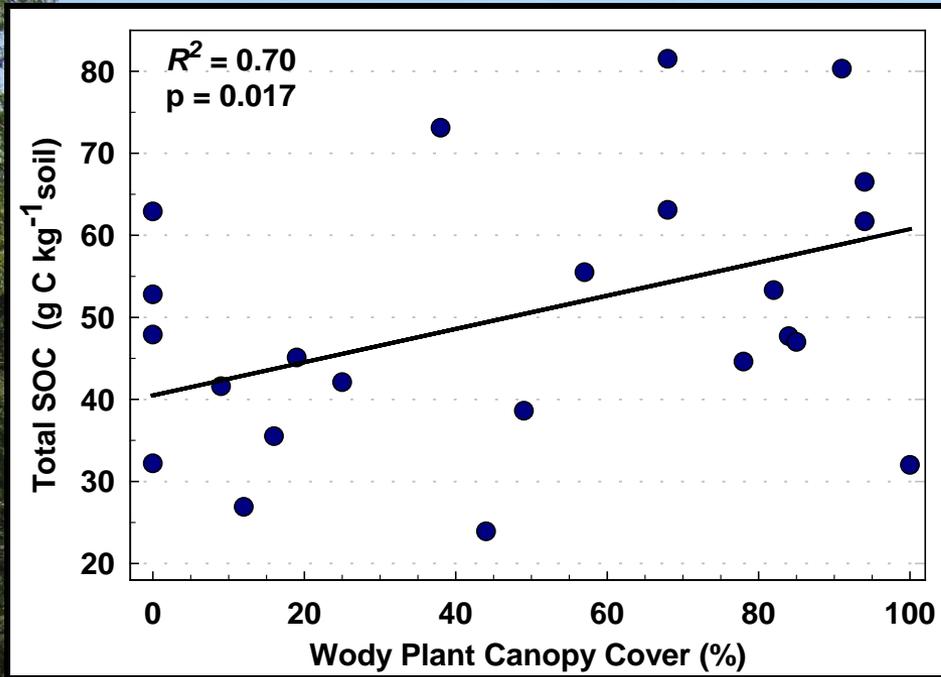
**39 g TC / kg**  
**2.9 g TN / kg**



**Ecosystem Service:**  
**Nutrient cycling**

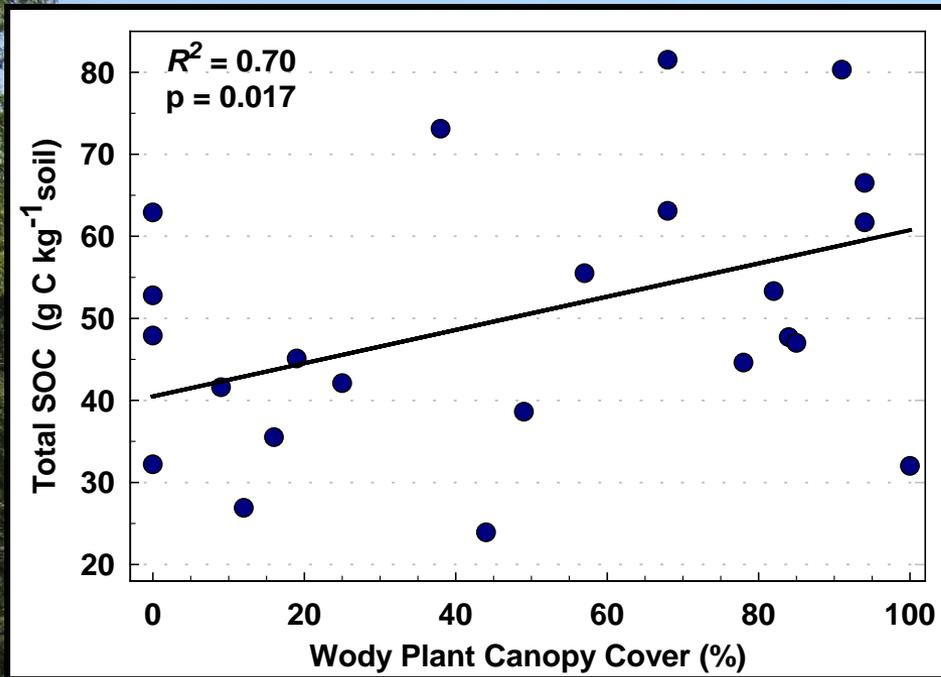
**Metric: TC & TN**

# ISLANDS OF FERTILITY

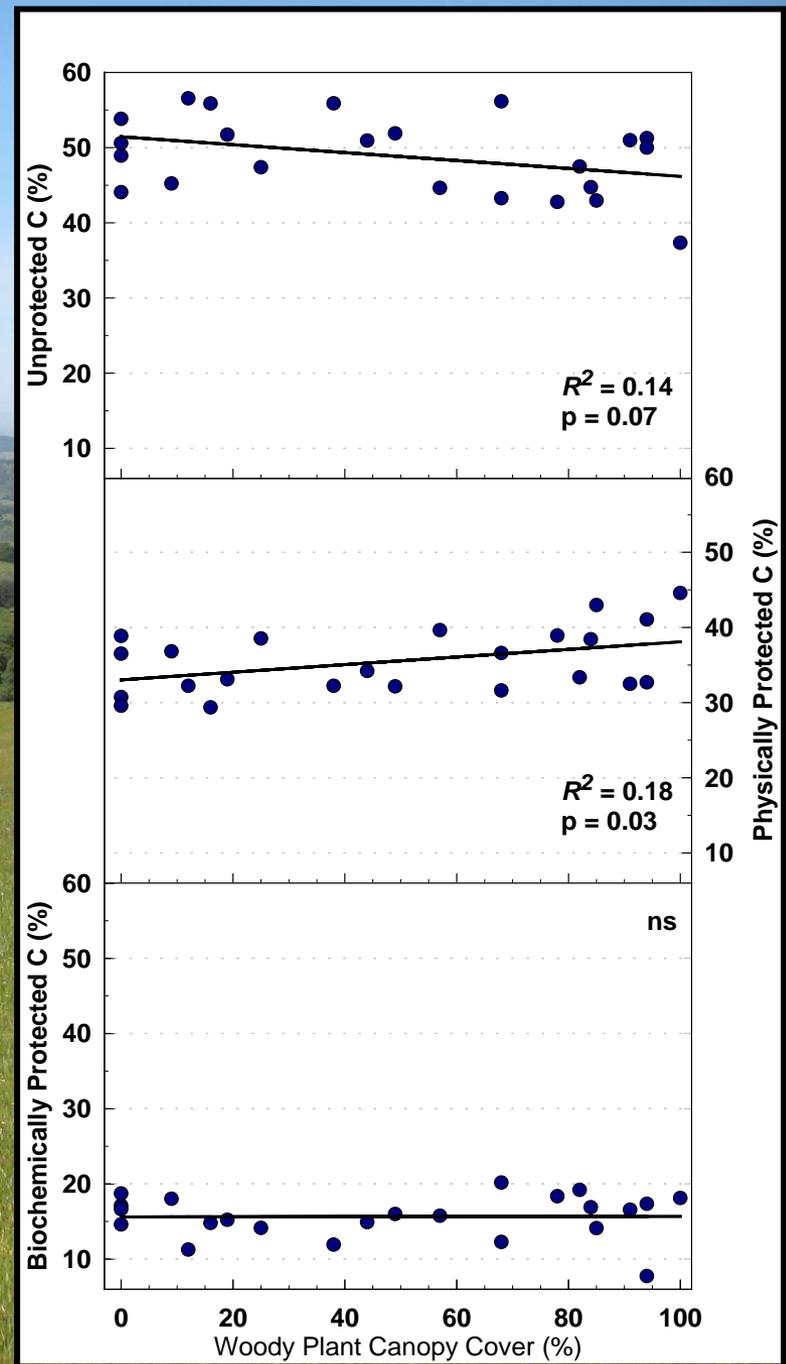


*Chang et al. In Prep. "Stability of soil organic carbon pools across common rangeland agricultural management regimes".*

# ISLANDS OF FERTILITY



Chang et al. In Prep. "Stability of soil organic carbon pools across common rangeland agricultural management regimes".



# SOIL PHYSICAL PROPERTIES

---

**'Undisturbed' Woodland  
>50% Canopy**

**130 cm / hr**



***Annual Grassland***

**20 cm / hr**



***Blue Oak Savanna  
<50% Canopy***

**90 cm / hr**

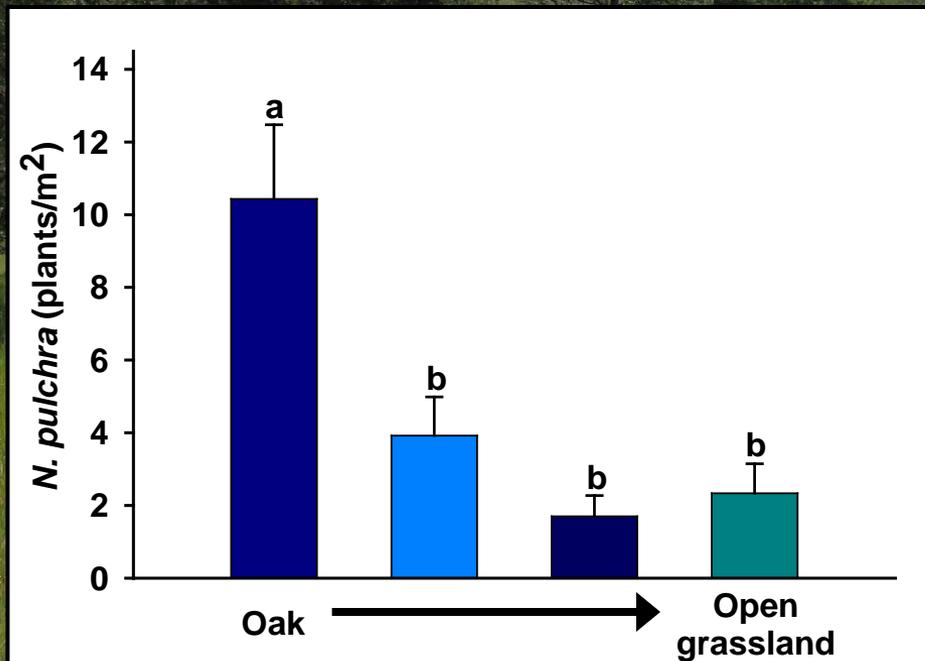


**Ecosystem Service:  
Water Supply**

**Metric: Infiltration**

# HERBACEOUS PLANT COMMUNITIES

Plot Location	Diversity ( $H'$ )	
	2010	2011
Grassland	1.82 (0.08) b	1.71 (0.08) b
Savanna	2.06 (0.09) a	2.07 (0.07) a
Woodland	2.24 (0.06) a	2.19 (0.05) a



Roche et al. 2012

**Ecosystem Service:  
Biodiversity**

**Metric: Diversity ( $H'$ )**

# AGRICULTURAL GOALS

---

**'Undisturbed' Woodland  
>50% Canopy**

**1330 kg / ha**



***Annual Grassland***

**3100 kg / ha**



***Blue Oak Savanna  
<50% Canopy***

**1810 kg / ha**



**Ecosystem Service:  
Agricultural Production**

**Metric: ANPP**

# AGRICULTURAL GOALS

**'Undisturbed' Woodland  
>50% Canopy**

**0.5 AUM / ac**

**\$9 / ac**



***Annual Grassland***

**1.8 AUM / ac**

**\$31 / ac**



***Blue Oak Savanna  
<50% Canopy***

**0.9 AUM / ac**

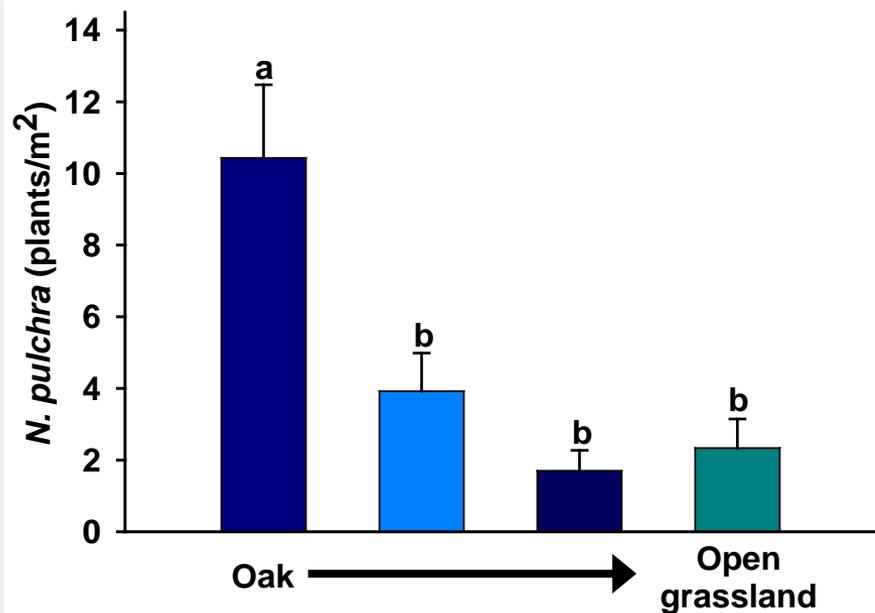
**\$15 / ac**



**Ecosystem Service:  
Agricultural Production  
Metric: Carrying capacity**

# OAK MANAGEMENT – TRADEOFFS & SYNERGIES

Metric	Woodland	Grassland	Savanna
ANPP (kg/ha)	1330	3100	1810
Total N (g/kg)	3.2	2.5	2.9
Total C (g/kg)	46	29	39
Infiltration (cm/hr)	130	20	90
Diversity (H')	2.10	1.54	2.07



# MANAGING FOR MULTIPLE OUTCOMES

---

**STMs** – Platform for visualizing the tradeoffs/ synergies among conservation & production goals

- *Challenge of “boxing” ourselves in*

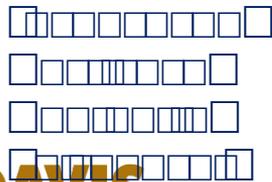
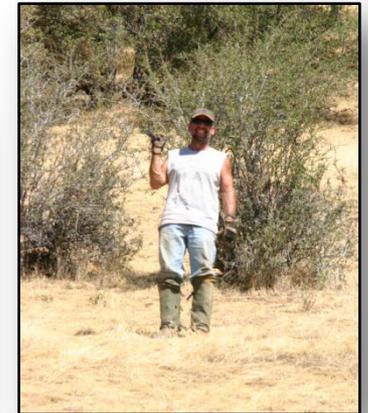
**Next steps** – Participatory research

- *Stakeholder-prescribed grazing study*
- *On-ranch surveys*



# ACKNOWLEDGEMENTS

- Martin Beaton
- Jiayou Deng
- Donna Dutra
- DJ Eastburn
- Dustin Flavell
- Thomas Lushinsky
- Mark Noyes
- Alexis Robertson
- Natalie Wegner
- Mike Williams

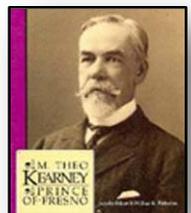


**UC DAVIS**

**DEPARTMENT OF PLANT SCIENCES**

*College of Agricultural and Environmental Sciences*

*Kearney Foundation  
of Soil Science*

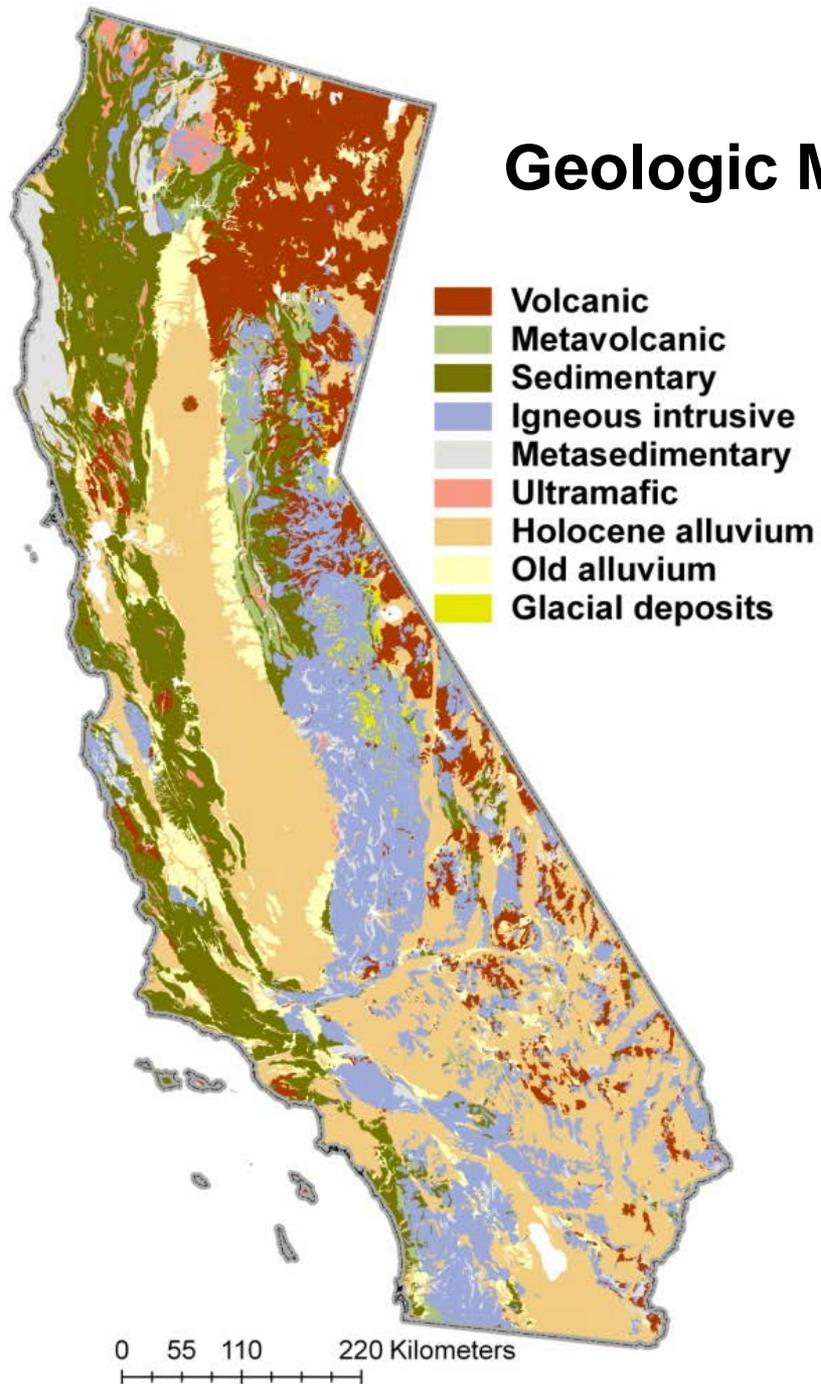


# California Rangeland Watershed Laboratory

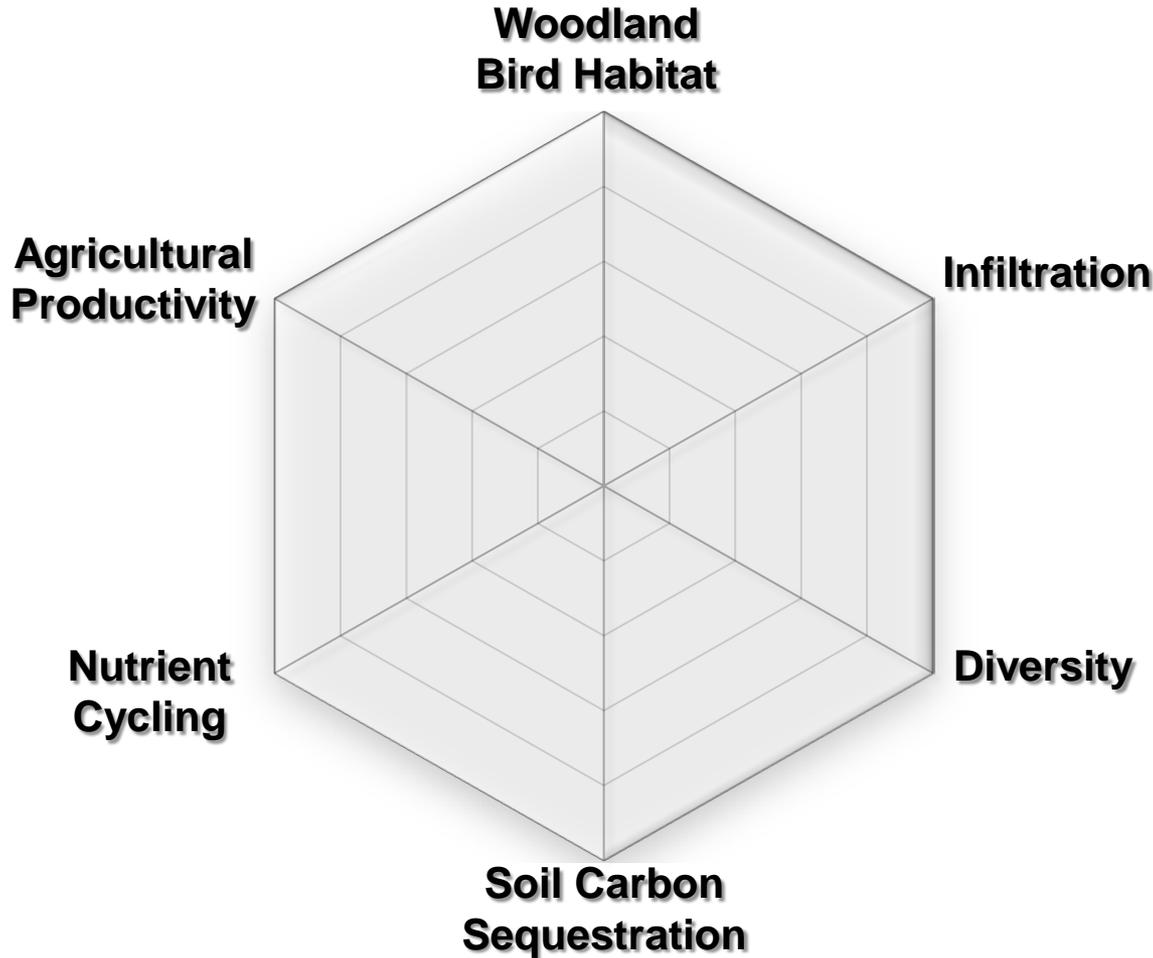
<http://rangelandwatersheds.ucdavis.edu>  
Google “rangeland watersheds”



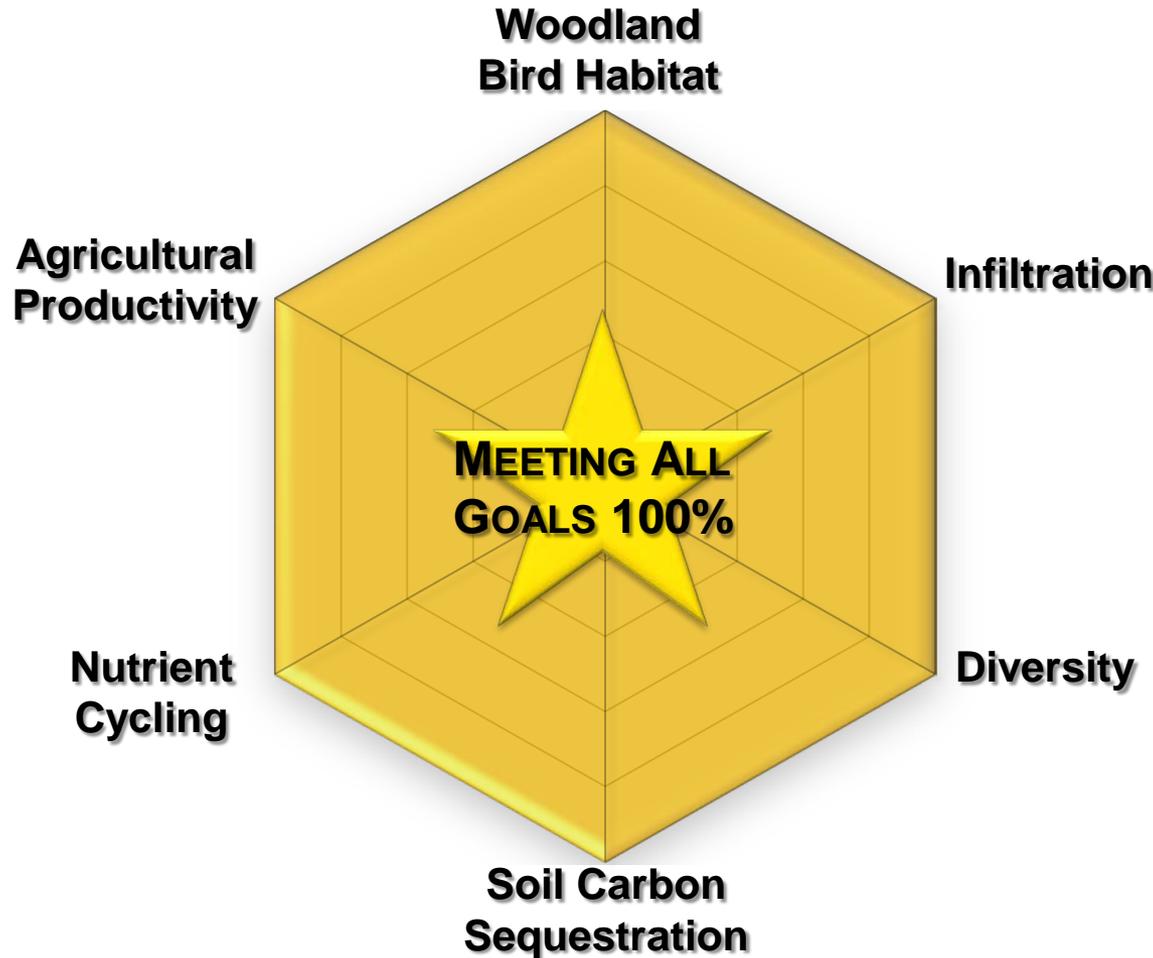
# Geologic Map



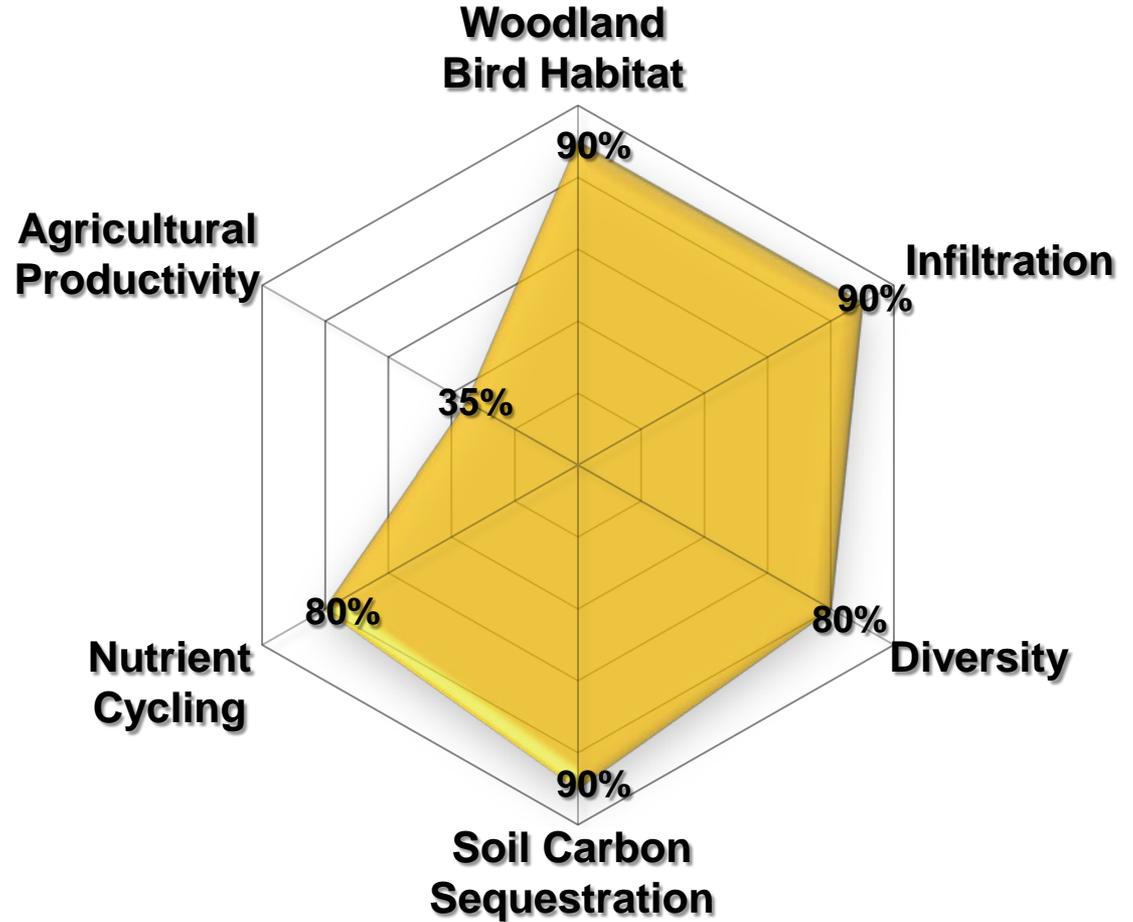
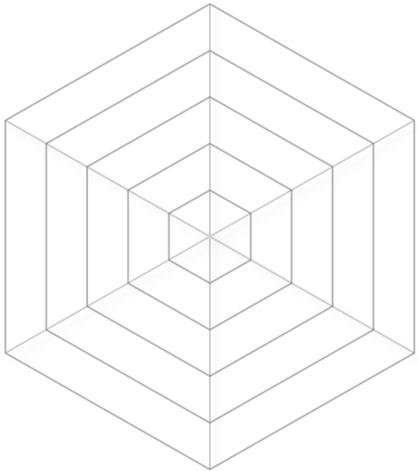
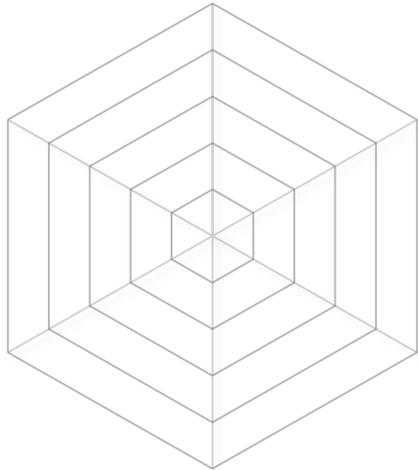
# MERGING CONSERVATION & PRODUCTION-BASED GOALS: CA HARDWOOD RANGELANDS



# MERGING CONSERVATION & PRODUCTION-BASED GOALS: CA HARDWOOD RANGELANDS

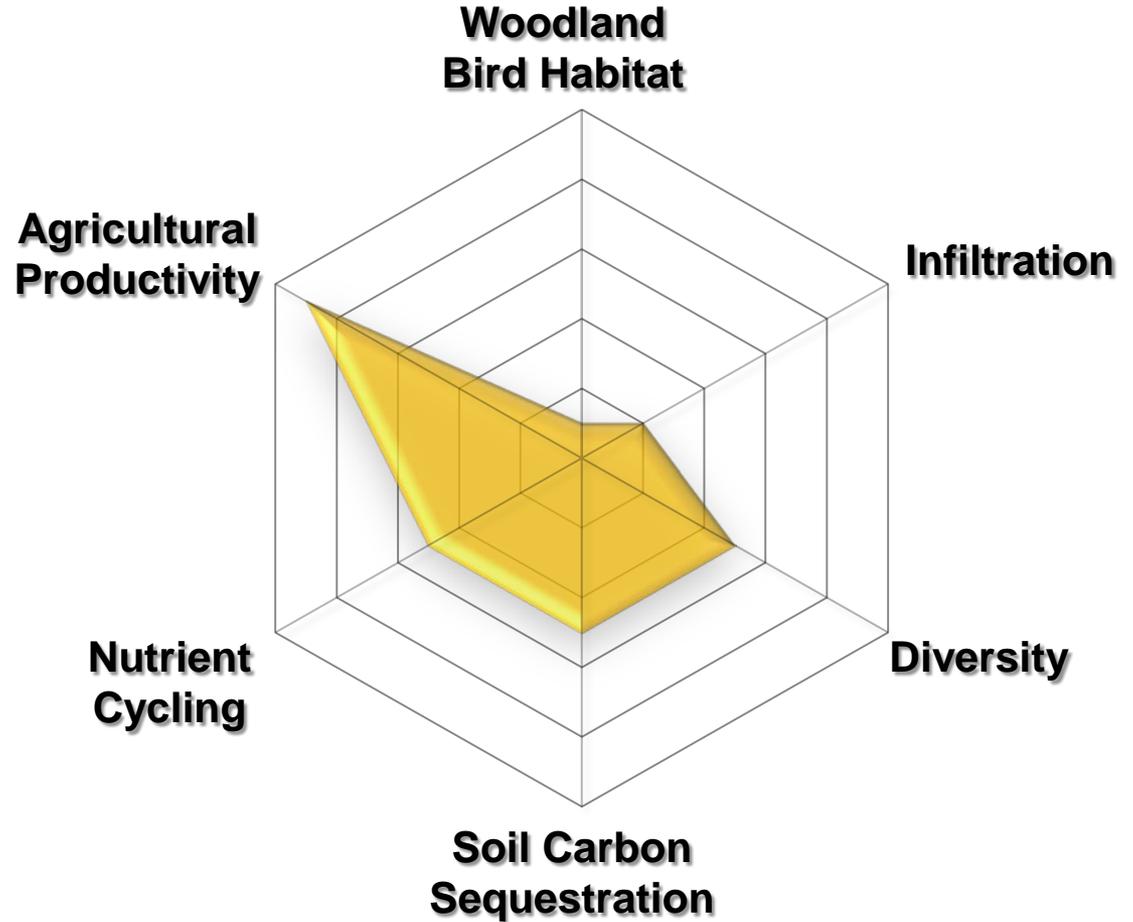
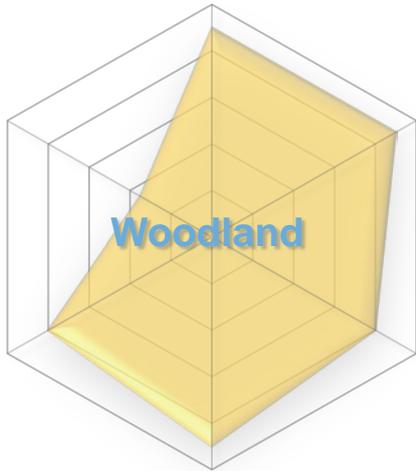


# CA HARDWOOD RANGELAND MANAGEMENT



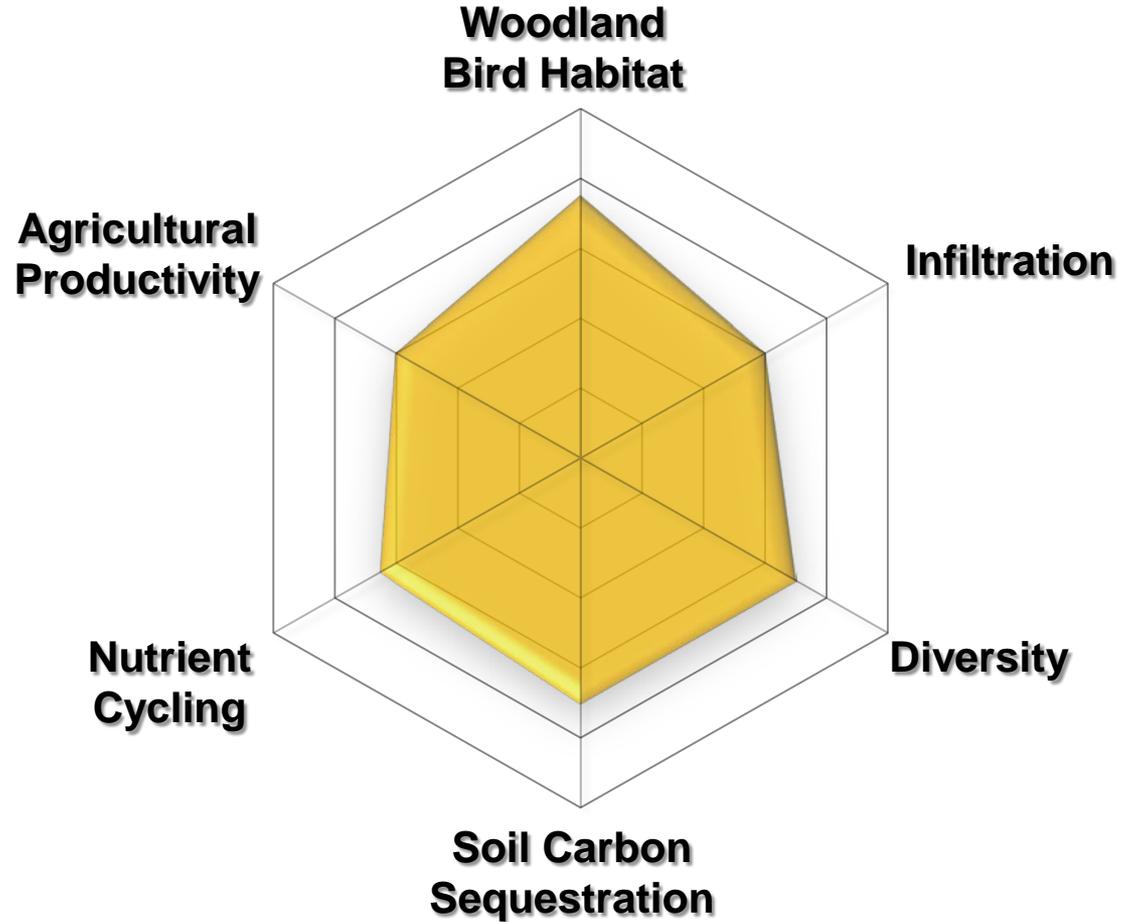
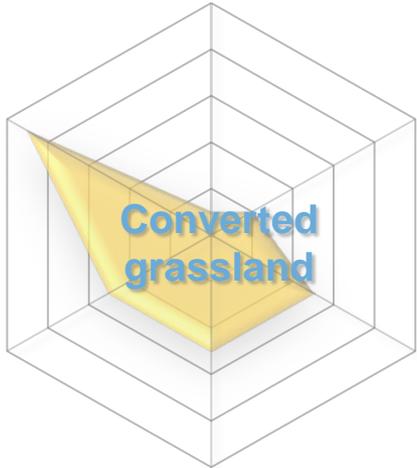
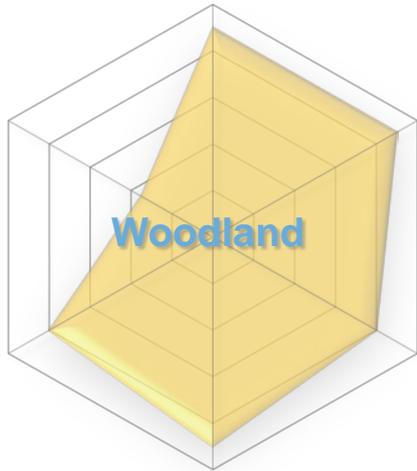
Undisturbed woodland  
(>50% canopy)

# CA HARDWOOD RANGELAND MANAGEMENT



Type-converted, open  
grassland

# CA HARDWOOD RANGELAND MANAGEMENT



Selectively thinned  
Savanna (<50% canopy)