

# Water Quality Conditions Associated with Cattle Grazing and Recreation on National Forest Lands



**Leslie Roche<sup>1</sup>, Rob Atwill<sup>2</sup>, Randy Dahlgren<sup>3</sup>, Ken Tate<sup>1</sup>**

<sup>1</sup>Plant Sciences, UC Davis; <sup>2</sup>School of Veterinary Medicine, UC Davis; <sup>3</sup>Land, Air and Water Resources, UC Davis

*The 3rd Rustici Rangeland Science Symposium*

March 3-4, 2015 • UC Davis Conference Center



**UC DAVIS**  
UNIVERSITY OF CALIFORNIA

 **UC DAVIS**  
VETERINARY MEDICINE



**100**  
UC Cooperative  
Extension

University of California  
Agriculture and Natural Resources



# Sacramento Bee Exclusive, 2010

## USFS Grazing Allotments

“Nowhere is the water dirtier...”

“Livestock waste found to foul  
Sierra waters”

“...incredible weapon of mass  
destruction”

# Multi-Partner Collaboration

---

- **US Forest Service**
- **UC Davis**
- **UC Cooperative Extension**
- **USFS Permittees**
- **Regional Water Quality Control Boards**
- **Rangeland and Forest Stakeholders**





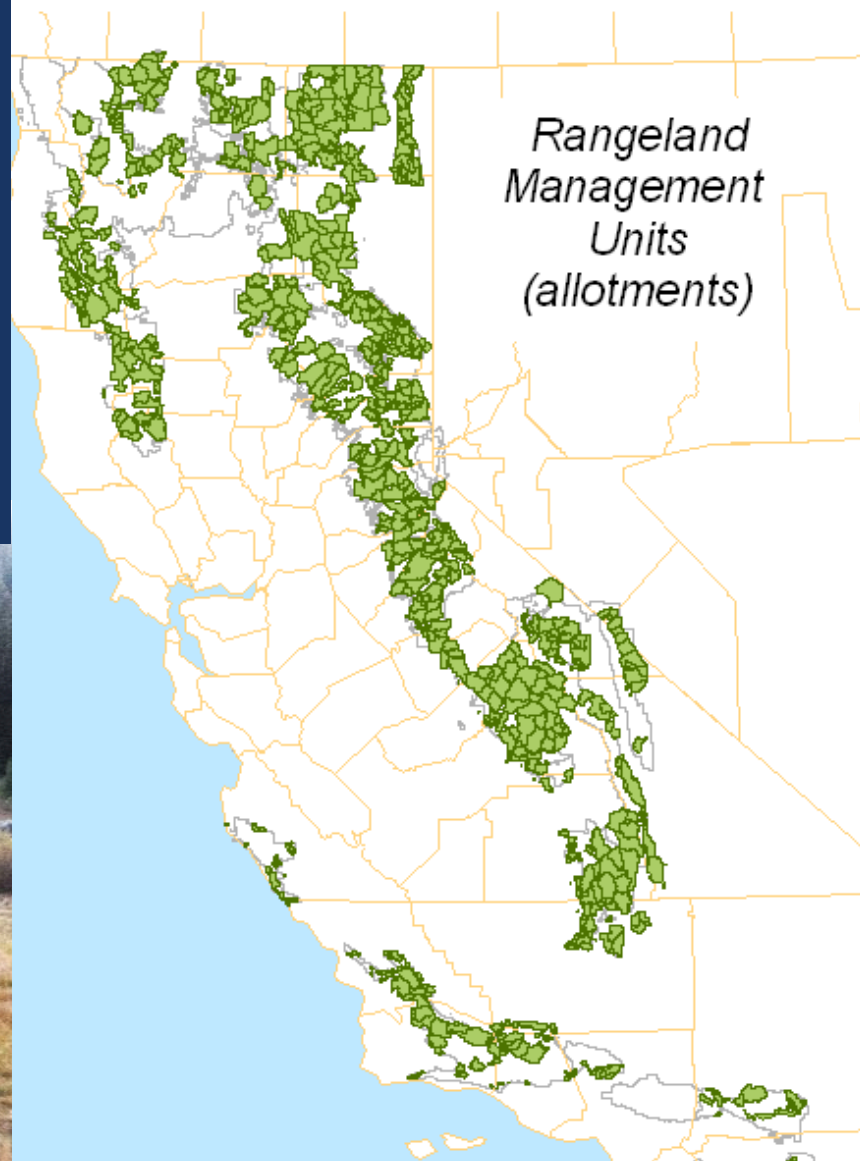
# USFS Public Grazing Allotments in CA

**500 Grazed Allotments**

**8,000,000 Acres**

**330,000 Animal Unit Months**

**~70,000 Head of Cattle**



# USFS Public Grazing Allotments in CA

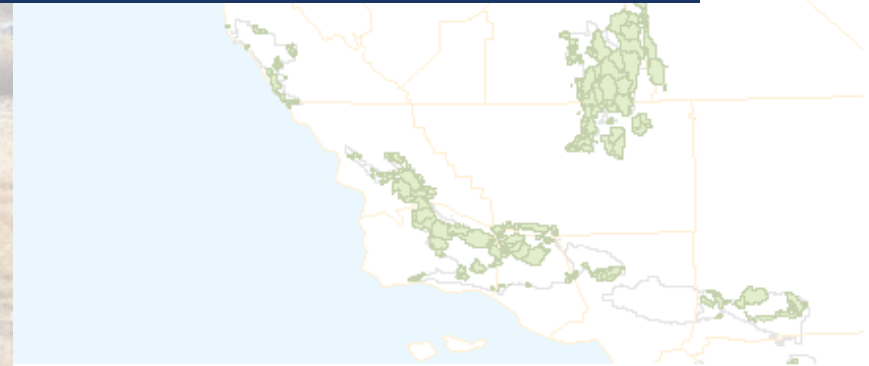
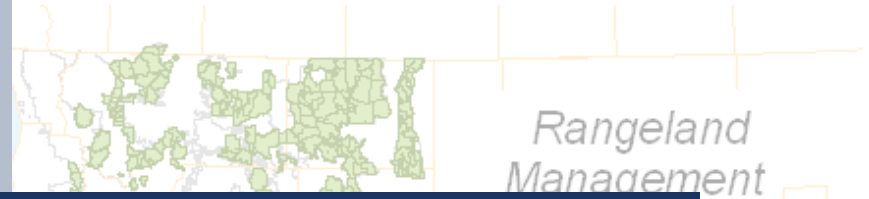
500 Grazed Allotments

8,000,000 Acres

330,

~70,

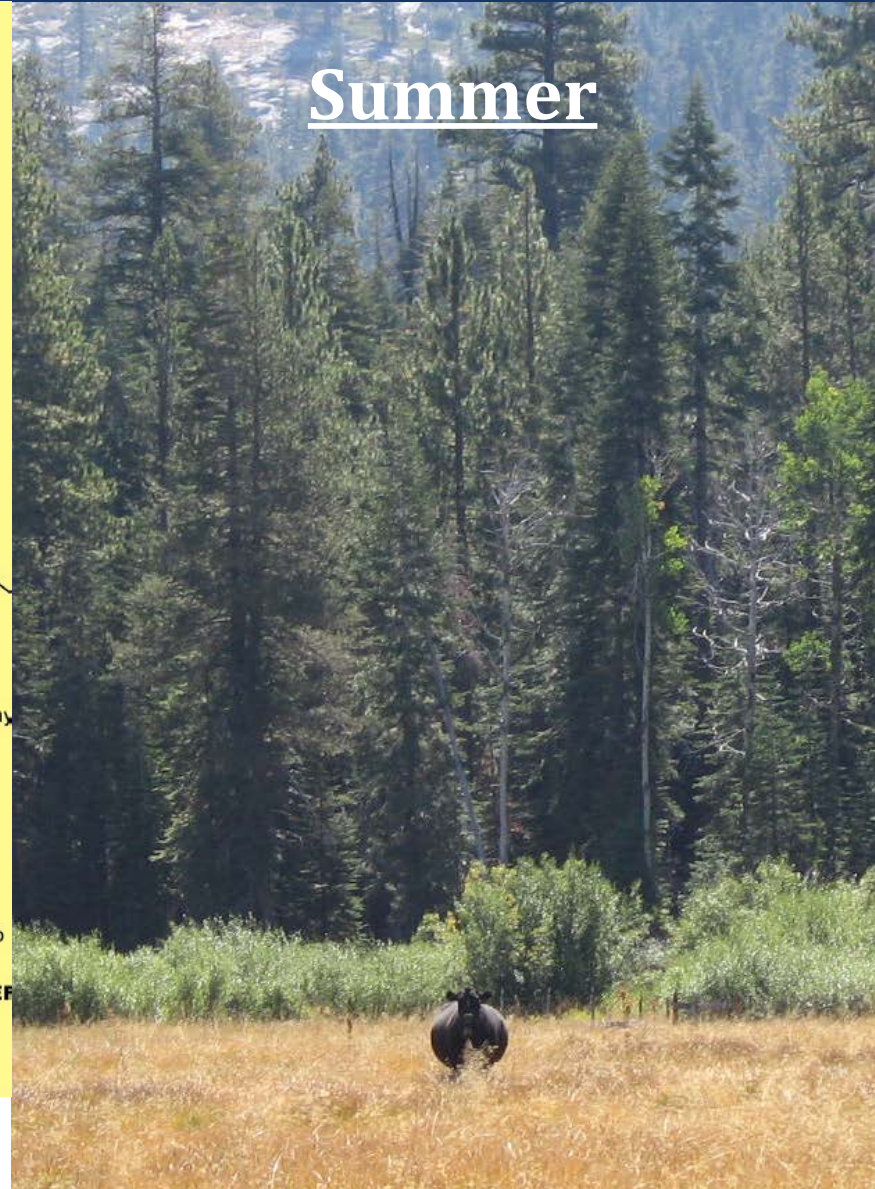
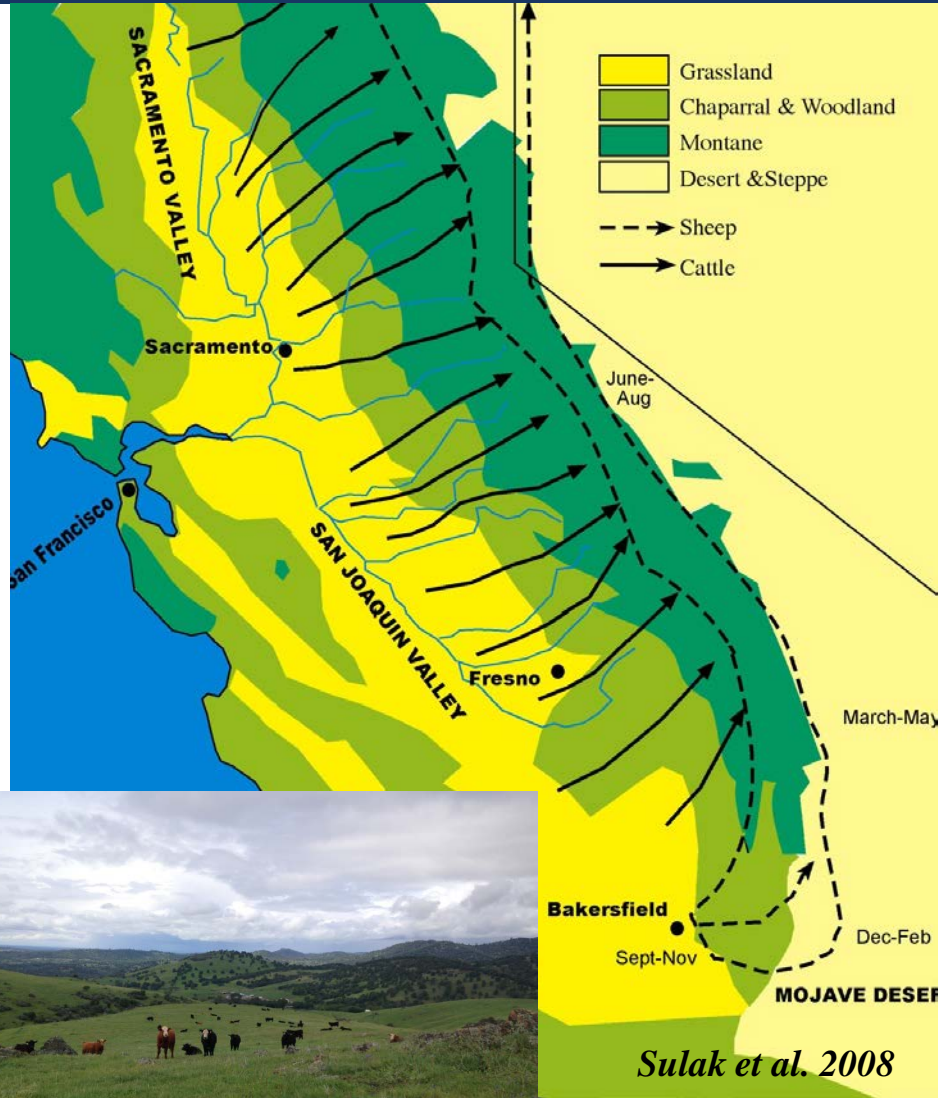
**Annual recreating  
population of 26  
million people.**





# Private Foothill Ranches & High Elevation Public Lands Connection

Summer



Fall - Spring

# Public Lands Grazing & Water Quality Objectives

---

*Public lands cattle grazing degrading environmental quality and putting human health at risk?*



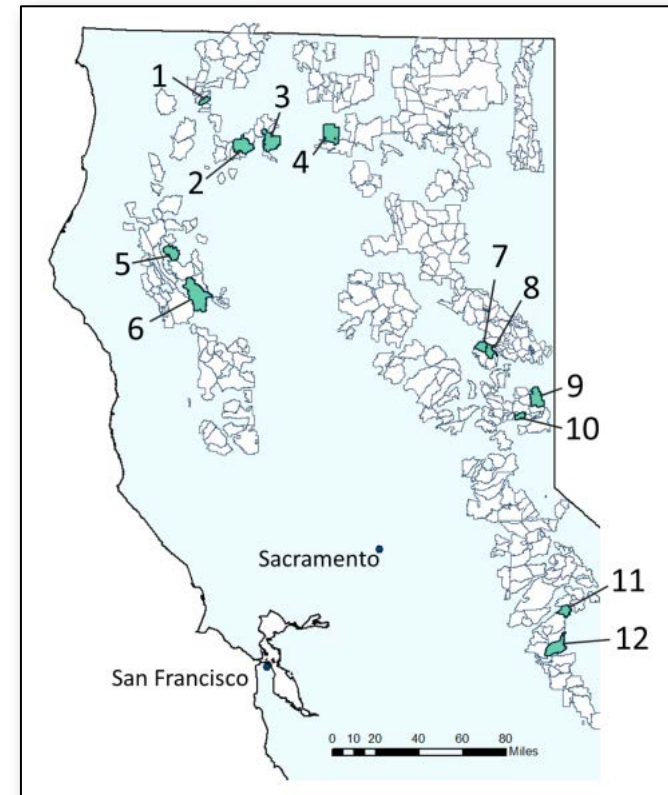


# Public Lands Grazing & Water Quality

## Cross-sectional, Longitudinal Survey

### 12 USFS public lands grazing allotments, 5 National Forests

- Klamath, Coast, Cascade, and Sierra Nevada Mountain Ranges.
- Represent diversity of climate, soil, vegetation, and resource use activities found across landscape.
- Study area: 320,000 acres.
- Elevation: 700-10,000 feet.





# Public Lands Grazing & Water Quality

## Cross-sectional, Longitudinal Survey

---

**12 USFS public lands grazing allotments, 5 National Forests**

***155 sample sites*** monitored monthly during grazing-recreation period (Jun-Nov, 2011).

- **Key Grazing Areas** – Meadows/riparian areas cattle known to graze and occupy.



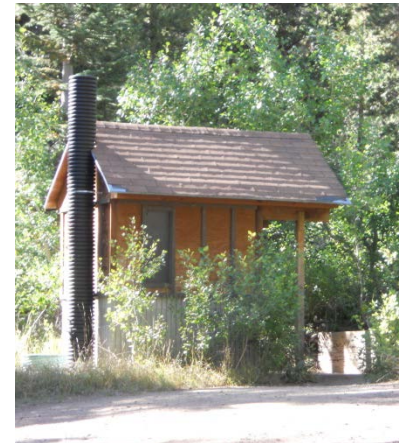
# Public Lands Grazing & Water Quality Comprehensive Survey

---

**12 USFS public lands grazing allotments, 5 National Forests**

***155 sample sites*** monitored monthly during grazing-recreation period (Jun-Nov, 2011).

- **Recreation Areas** – Developed/undeveloped campgrounds, swimming areas, trailheads.





# Public Lands Grazing & Water Quality Comprehensive Survey

---

**12 USFS public lands grazing allotments, 5 National Forests**

***155 sample sites*** monitored monthly during grazing-recreation period (Jun-Nov, 2011).

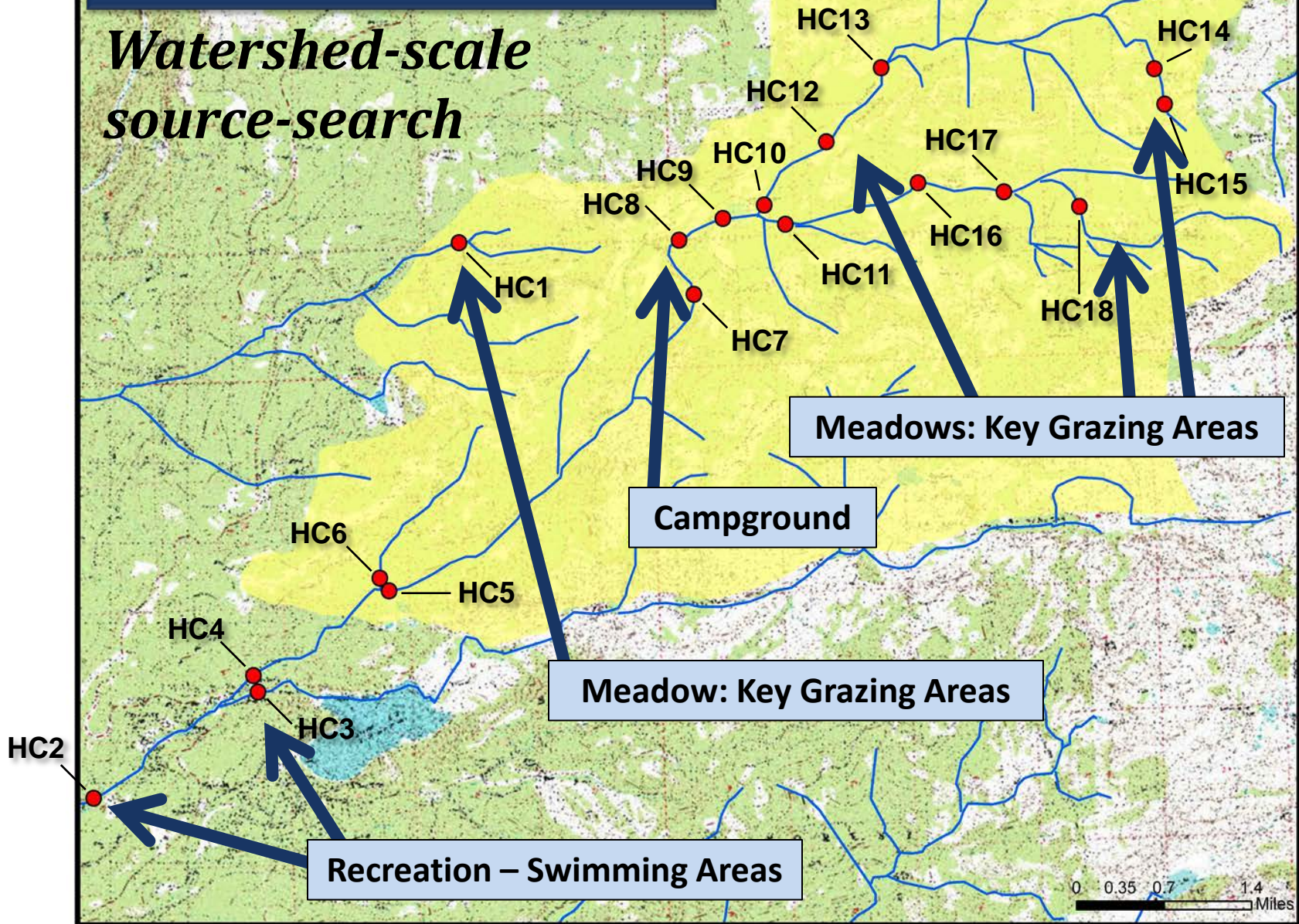
- **No Concentrated Use Activities**– Perennial flow tributary confluences with no concentrated use activities.





# Sample Site Selection

*Watershed-scale  
source-search*





# Water Quality - Measurements

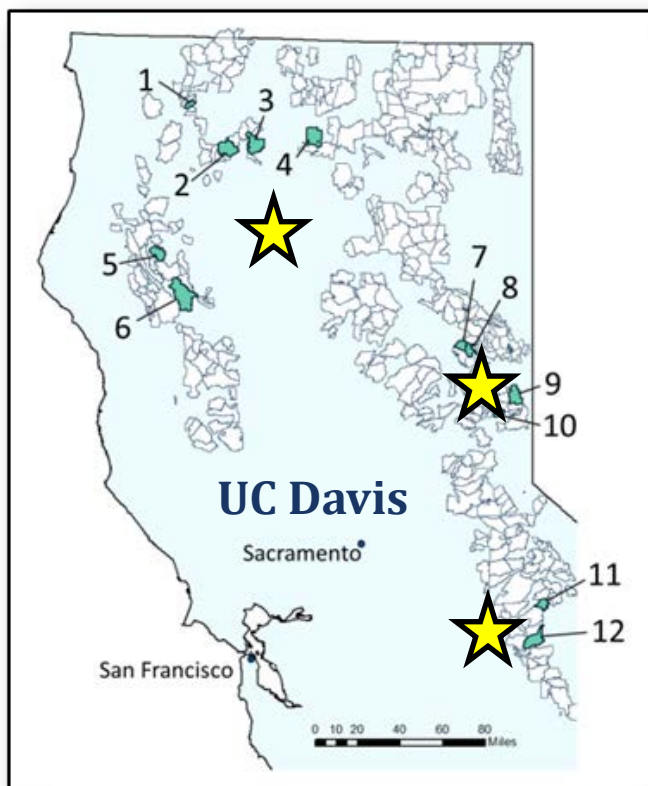
A background image showing laboratory equipment for water quality analysis. It includes a glass beaker with a yellowish liquid, a white pipette, and a hand in a white glove holding a pipette tip. The scene is set on a laboratory bench with various containers and equipment.

**All 155 Sample Sites, Every Sample Event:**

- “Indicator” *E. coli* and fecal coliform (FIBs)
- Total N, nitrate ( $\text{NO}_3\text{-N}$ ), ammonium ( $\text{NH}_4\text{-N}$ )
- Total phosphorus and soluble-reactive phosphorus ( $\text{PO}_4\text{-P}$ )

# FIB Analysis Conducted w/in 8 hours

*3 remote laboratories established to meet maximum 8 hour hold time restrictions.*





# Water Quality Benchmarks

Percentage of 743 stream *water samples* exceeding benchmarks

Benchmark	Overall (% of 743)	Key Grazing Area (% of 462)	Recreation Area (% of 125)	No Concentrated Use Activities (% of 156)
FC > 20 cfu/100ml	50	48	46	58
FC > 200 cfu/100ml	10	10	6	13
<i>E. coli</i> > 100 cfu/100ml	9	8	7	11
<i>E. coli</i> > 235 cfu/100ml	3	3	3	4
NO <sub>3</sub> -N > 300 µg/L	0	0	0	0
TP > 100 µg/L	2	2	2	<1
PO <sub>4</sub> -P > 50 µg/L	<1	1	0	0



# Water Quality Benchmarks

Percentage of 743 stream *water samples* exceeding benchmarks

Benchmark	Overall (% of 743)	Key Grazing Area (% of 462)	Recreation Area (% of 125)	No Concentrated Use Activities (% of 156)
FC > 20 cfu/100ml	50	48	46	58
FC > 200 cfu/100ml	10	10	6	13
<i>E. coli</i> > 100 cfu/100ml	9	8	7	11
<i>E. coli</i> > 235 cfu/100ml	3	3	3	4
NO <sub>3</sub> -N > 300 µg/L	0	0	0	0
TP > 100 µg/L	2	2	2	<1
PO <sub>4</sub> -P > 50 µg/L	<1	1	0	0



# Water Quality Benchmarks

Percentage of 743 stream *water samples* exceeding benchmarks

Benchmark	Overall (% of 743)	Key Grazing Area (% of 462)	Recreation Area (% of 125)	No Concentrated Use Activities (% of 156)
FC > 20 cfu/100ml	50	48	46	58
FC > 200 cfu/100ml	10	10	6	13
<b><i>E. coli</i> &gt; 100 cfu/100ml</b>	9	8	7	11
<b><i>E. coli</i> &gt; 235 cfu/100ml</b>	3	3	3	4
NO <sub>3</sub> -N > 300 µg/L	0	0	0	0
TP > 100 µg/L	2	2	2	<1
PO <sub>4</sub> -P > 50 µg/L	<1	1	0	0

# Water Quality Benchmarks

Percentage of 743 stream *water samples* exceeding benchmarks

Benchmark	Overall (% of 743)	Key Grazing Area (% of 462)	Recreation Area (% of 125)	No Concentrated Use Activities (% of 156)
FC > 20 cfu/100ml	50	48	46	58
FC > 200 cfu/100ml	10	10	6	13
<i>E. coli</i> > 100 cfu/100ml	9	8	7	11
<i>E. coli</i> > 235 cfu/100ml	3	3	3	4
<b>NO<sub>3</sub>-N &gt; 300 µg/L</b>	0	0	0	0
<b>TP &gt; 100 µg/L</b>	2	2	2	<1
<b>PO<sub>4</sub>-P &gt; 50 µg/L</b>	<1	1	0	0



# Mean FIB Concentrations

Benchmark	Key Grazing Area (n = 462)	Recreation Area (n = 125)	No Concentrated Use Activities (n = 156)
FC (cfu 100/ml)	87 ± 12 a	55 ± 9 b	90 ± 12 a
<i>E. coli</i> (cfu 100/ml)	42 ± 6 a	29 ± 7 b	43 ± 8 a

*No significant differences in FIB concentrations between key grazing areas and areas of no concentrated use activities.*

# Mean FIB Concentrations

Benchmark	Key Grazing Area (n = 462)	Recreation Area (n = 125)	No Concentrated Use Activities (n = 156)
FC (cfu 100/ml)	87 ± 12 a	55 ± 9 b	90 ± 12 a
<i>E. coli</i> (cfu 100/ml)	42 ± 6 a	29 ± 7 b	43 ± 8 a

*FIB concentrations significantly lower at recreation areas.*



# Mean FIB Concentrations

Benchmark	Key Grazing Area (n = 462)	Recreation Area (n = 125)	No Concentrated Use Activities (n = 156)
FC (cfu 100/ml)	87 ± 12 a	55 ± 9 b	90 ± 12 a
<i>E. coli</i> (cfu 100/ml)	42 ± 6 a	29 ± 7 b	43 ± 8 a

***Mean FIB concentrations still below USEPA *E. coli* FIB-based benchmarks.***

# Mean FIB Concentrations

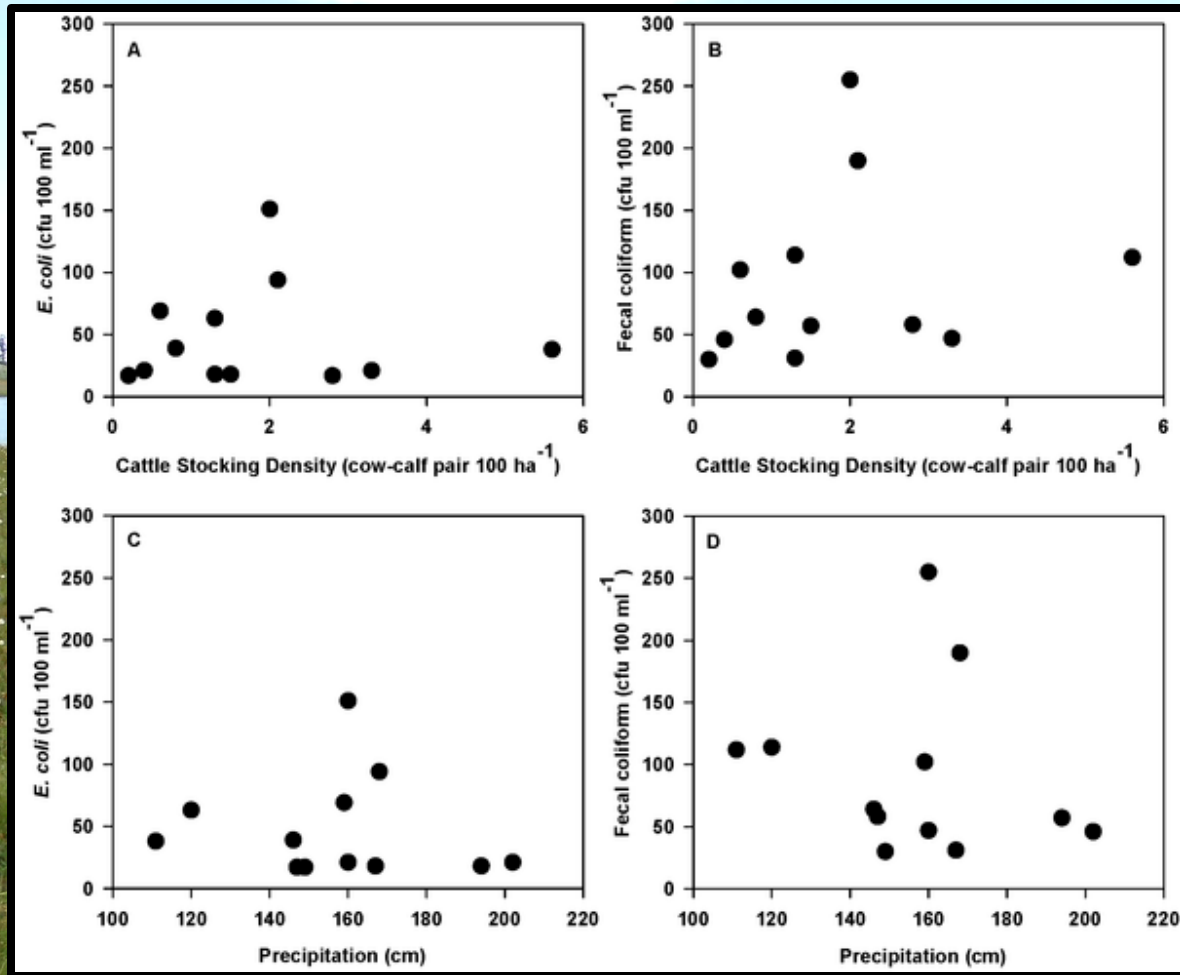
## Relative to conditions at time of collection

	Low Stream Flow		Turbid Water		Cattle Present		Recreation	
	Yes	No	Yes	No	Yes	No	Yes	No
No. Occurrences	51	692	37	706	130	613	28	715
FC (cfu/100 ml)	216**	72	212**	76	205**	56	36	84
<i>E. Coli</i> (cfu/100 ml)	114*	35	142**	35	115**	24	14*	41

\*\*  $P < 0.05$  ; \*  $P < 0.01$

**FIB concentrations higher when stream flow was low/stagnant, stream water was turbid, and when cattle were actively observed at sampling.**

# Allotment-Level Mean FIB Concentrations



*No statistically significant relationships between FIB and cattle density or precipitation.*



# Public Lands Grazing & Water Quality

## Conclusions

---

- Observed nutrient concentrations were  $\geq 1$  order of magnitude below levels of ecological concern, and similar to background estimates.
- All but the most out-of-date and restrictive fecal indicator bacteria (FIB) water quality benchmarks were broadly met.
- Throughout the study period, US EPA recommended *E. coli* benchmarks were met for >90% of samples collected and >83% of sites (no exceedances).

# Public Lands Grazing & Water Quality

## Conclusions

---

- Observed nutrient concentrations were  $\geq 1$  order of magnitude below levels of ecological concern, and similar to background estimates.
- All but the most out-of-date and restrictive fecal indicator bacteria (FIB) water quality benchmarks were broadly met.
- Throughout the study period, US EPA recommended *E. coli* benchmarks were met for >90% of samples collected and >83% of sites (no exceedances).

*“Our results do not support previous concerns of widespread microbial water quality pollution across these grazed landscapes, as concluded in other surveys.”*

# *Why are our conclusions different than other surveys?*

---

## **3 important distinctions**

- 1) Study results compared to regulatory and background water quality benchmarks based on current science and policy.**
- 2) Land-use activities were directly compared on the same land units managed by a single agency (USFS).**
- 3) To date, this study is the most comprehensive water quality survey in existence for National Forest public grazing lands, including an assessment of 7 water quality indicators at 155 sites across 5 National Forests.**



# Rangeland Watershed Laboratory

Roche, L.M., L. Kromschroeder, E. R. Atwill, R.A. Dahlgren, and K.W. Tate. 2013. Water Quality Conditions Associated with Cattle Grazing and Recreation on National Forest Lands. PLOS ONE 8(6): e68127.



<http://rangelandwatersheds.ucdavis.edu>

