

# *Clean Water, Healthy Soil, and Productive Ranches*

**Ken Tate, Rob Atwill, and a bunch of characters**

*UC Davis & UCCE*



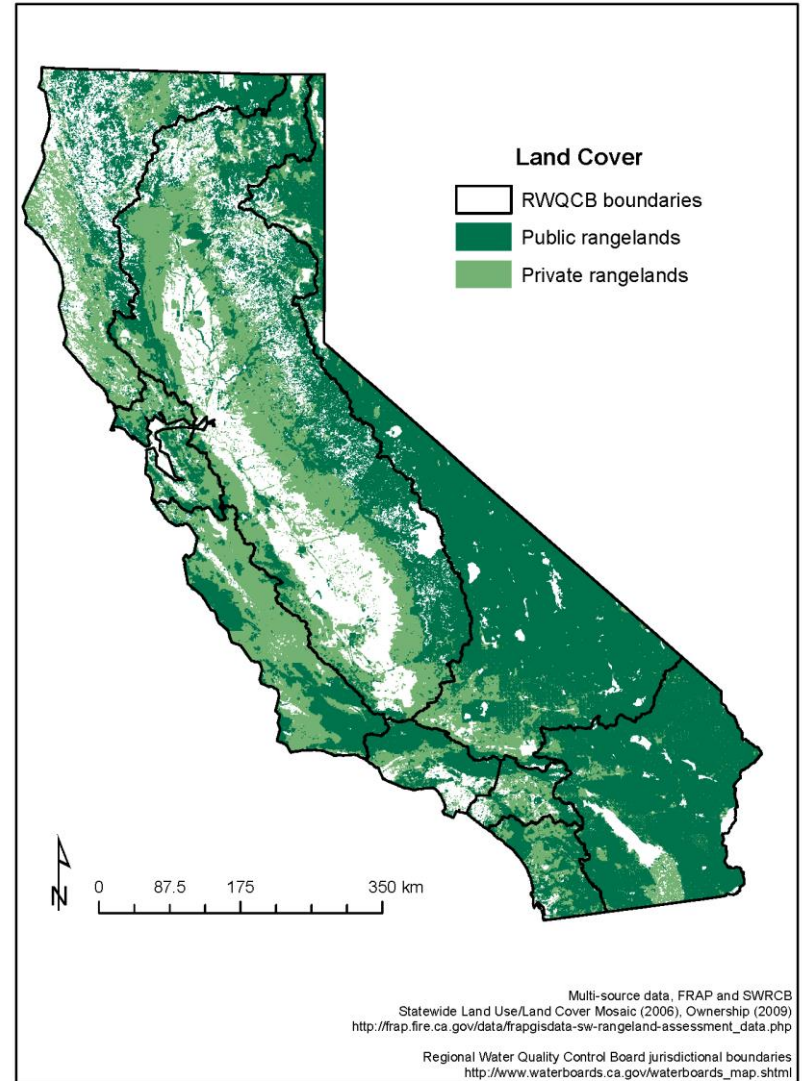
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**UC RANGELANDS**  
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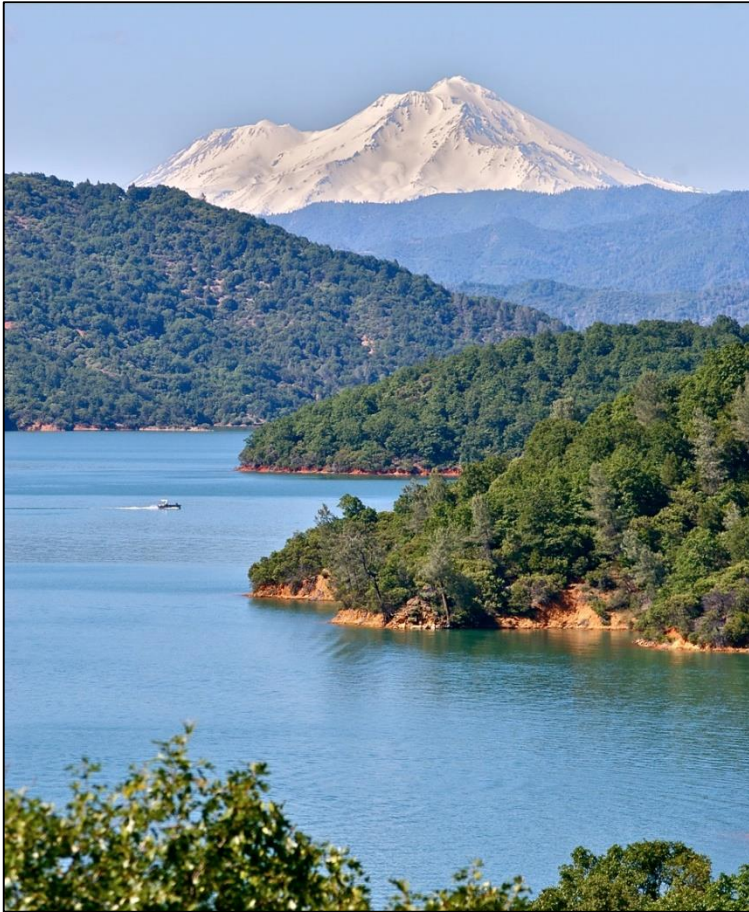
# CA Rangelands

- 57 M acres.
- 22 M acres privately owned.
- \$3 B annual sheep & cattle industry.
- 1000's of plant and animal species.
- Substantial carbon storage.



# CA Rangeland Watersheds

- ~80% of CA surface waters derived from, or stored on
- Safe water to drink, recreate, irrigate

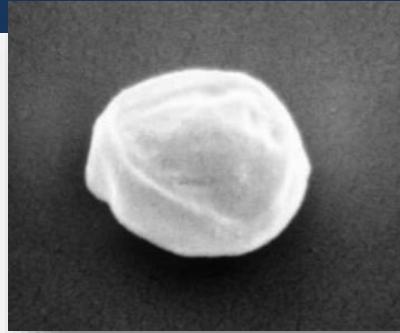


# 1997 Bay Area - Cryptosporidium

## Livestock



## Pathogens



*C. parvum*



## Drinking Water



**Contra Costa Times**  
Monday, January 6, 1997

### Tiny parasite has water districts, cattle ranch

By DENIS CUFF  
Staff writer

Cattle and water. They go together on many California landscapes where cows roam valleys above deep blue reservoirs.

A nasty bug has intruded on the pastoral scene: a parasite in animal droppings that can sicken people, even kill them when it gets into water sources.

Now some drinking water suppliers are questioning whether it's safe to mix cattle and reservoir lands.

The bug is cryptosporidium, a tough, tiny parasite that hits most people like the flu but can kill AIDS patients or others with compromised immune systems.

Cryptosporidium has captured the attention of the water industry in the past three years because of some unusual features.

JOHN GARRETT JACKSON, 15, herds cattle recently from one of his father's fields on a ranch on the family leased ranch property of Vasco Road.

**Parasite**  
FROM PAGE 1A

cond. "I think we are just beginning to understand that cryptosporidium is going to be a major water concern for the quality of drinking water in California."

The Contra Costa Water District this month recommended phasing out grazing in the buffer lands around its Los Vaqueros Reservoir under construction south of Brentwood. The reservoir will store drinking water for 400,000 people.

The neighboring East Bay Municipal Utility District is looking into tighter grazing restrictions on its land to protect its 1.9 million customers.

**Scientists seek watery solution to halt 'mystery spore' outbreak**

By DENIS CUFF  
Staff writer

You might call it the mystery bug. Scientists did, giving this parasite the name cryptosporidium that translates as "mystery spore."

The parasite repeatedly stumped scientists, who didn't discover until 1976 that the microscopic organism could harm people.

It took until the early 1980s to document the first case of the parasite moving through drinking water to infect a human and cause

tion Agency and the Centers for Disease Control.

Under a new information collection rule, the EPA is requiring large water suppliers next month to begin monitoring for cryptosporidium.

California has reported no water-transmitted outbreaks of the parasite. Water managers, however, have reported outbreaks in other states where the suppliers met federal regulations for water treatment.

The worst of America's six known outbreaks was in Milwaukee in 1993, where 400,000

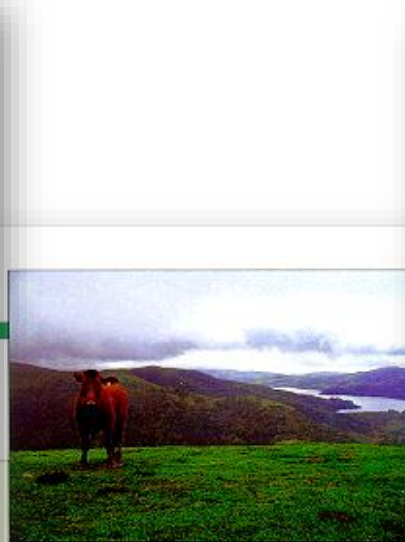
**Parasite risks**

Cryptosporidium kills the young mammals, especially calves. Of banning cattle — or maybe just the Los Vaqueros watershed? — of contracting cryptosporidiosis, but the district doesn't want to

**RECOMMENDATIONS**

San Francisco water district targets cattle

In February, the San Francisco Public Utilities Commission (PUC) seemed poised to ban cattle



**Water district backs away from cattle grazing ban around lake**

By DENIS CUFF  
Times Staff Writer

Backing off a proposed cattle ban to protect drinking water from a harmful parasite, a Contra Costa water supplier may allow some grazing on lands around the Los Vaqueros Reservoir.

Contra Costa Water District planners say it's enough to control grazing by selectively banning it in some areas, fencing off the reservoir, and banning young calves on most of the 18,000 acres around the reservoir.

Manure from young calves has the highest risk for spreading cryptosporidium, a bug that has made the water industry wary.

Widely found in America's wetlands and in feces of many wild and domestic animals, cryptosporidium can resist chlorine and slip through many water filters to make healthy people sick and kill those with weak immune systems.

"Calves are the major shedders of crypto, by eliminating them, we can control the risk," said John Steere, a district watershed planner. "This

JOE PAULO, foreground, and Russell Jackson keep an eye on their cattle from horseback on Walker Ranch, where Jackson leases land for his herd to graze.

**RECOMMENDATIONS**

district would install fencing to keep

## San Francisco water district targets cattle

ness (cryptosporidiosis) lasts only a few days in most people with healthy immune systems, but



For Immediate Release, November 21, 2017

## Cattle Waste Puts California's Point Reyes on 'Crappiest Places in America' List

POINT REYES, *Calif.*— The livestock-polluted waters of Point Reyes National Seashore rank in the top 10 percent of U.S. locations most contaminated by feces indicated by *E. coli* bacteria, according to a new [report](#) published on the investigative journalism website *The Revelator*.



# The Wildlife News

[ABOUT](#)   [HISTORY OF THE GREATER YELLOWSTONE WOLF RESTORATION](#)   [ABOUT HUNTING](#)

[BLOG COMMENT RULES](#)   [CENTRAL IDAHO](#)

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◀ [Public land takers advance in Western State Legislatures](#)

Latest in [Frank Ranches, et al. v. Jonathan Ratner, Western Watersheds Project](#) ▶

## Benefits of Removing Livestock from Rangelands to Sequester Carbon

by [GEORGE WUERTHNER](#) on [FEBRUARY 2, 2015](#) · [7 COMMENTS](#) · in [CATTLE](#), [CLIMATE CHANGE](#), [FEATURED](#), [GRAZING AND LIVESTOCK](#), [WILDLIFE NEWS](#)

### INTRODUCTION

Rangelands make up a large proportion of the Earth's surface, and the soils hold a significant amount of sequestered carbon. Rangelands are estimated to contain more than one-third of the world's above and below ground carbon reserves.<sup>[i]</sup> As a consequence, there is interest in determining the potential for soil carbon sequestration in rangeland soils, and whether livestock grazing helps or hinders this sequestration.

# Why meat eaters should think much more about soil

*John Sauven*

Tue 16 May 2017 02.00 EDT



7,408  914 

If over-grazing continues to cause soil degradation, we won't be able to feed people in the future. The answer? Eat grass-fed sustainable meat - or none at all



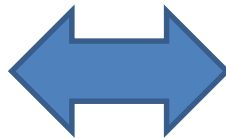
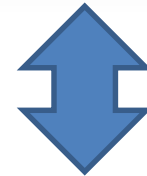
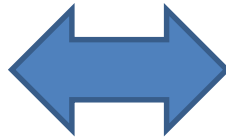
▲ Pig carcasses in an abattoir in Yorkshire. Photograph: FLPA/John Eveson/Rex

# What does science tell us?

- **Grazing management and rangeland...**
  - **Water quality**
  - **Soil health**

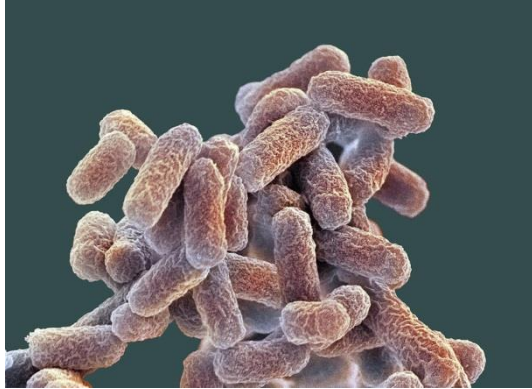


# Healthy soils, forage and livestock production, profitability, and clean water are interconnected...

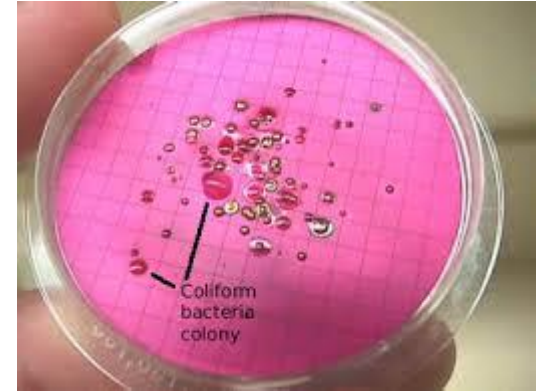


# Microbial Pollutants

Indicators

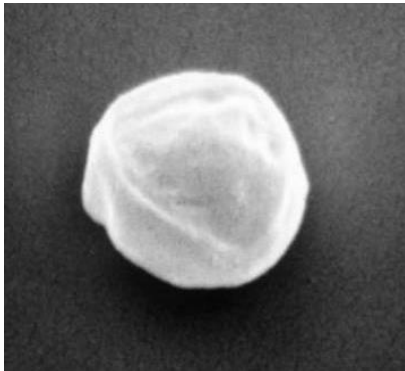


Fecal coliforms  
Indicator *E. coli*

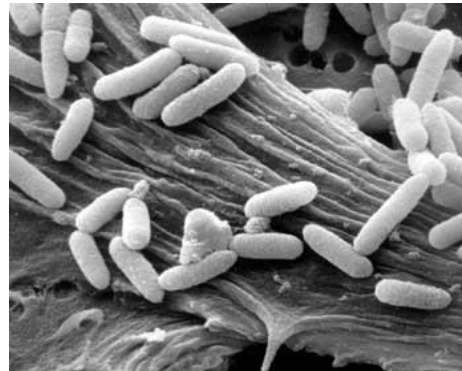


We regulate on bacteria that when present in water we hope indicate the presence of pathogens.

Pathogens



*C. parvum*



*E. Coli O157:H7*



*Salmonella*

# Grazing Lands – Our Line of Research

## Rangeland Water Pollutants of Concern

*nutrients, microbes, hormones, pharmaceuticals*

Livestock Sources

Background &  
Other Sources

Pollutant Transport and Environmental  
Fate Dynamics

Management  
Solutions

Water Quality Conditions

• *Sources*

• *Fate and Transport*

• *Mitigate Risks*

• *Provision Clean Water*

# Grazing Lands – Our Line of Research

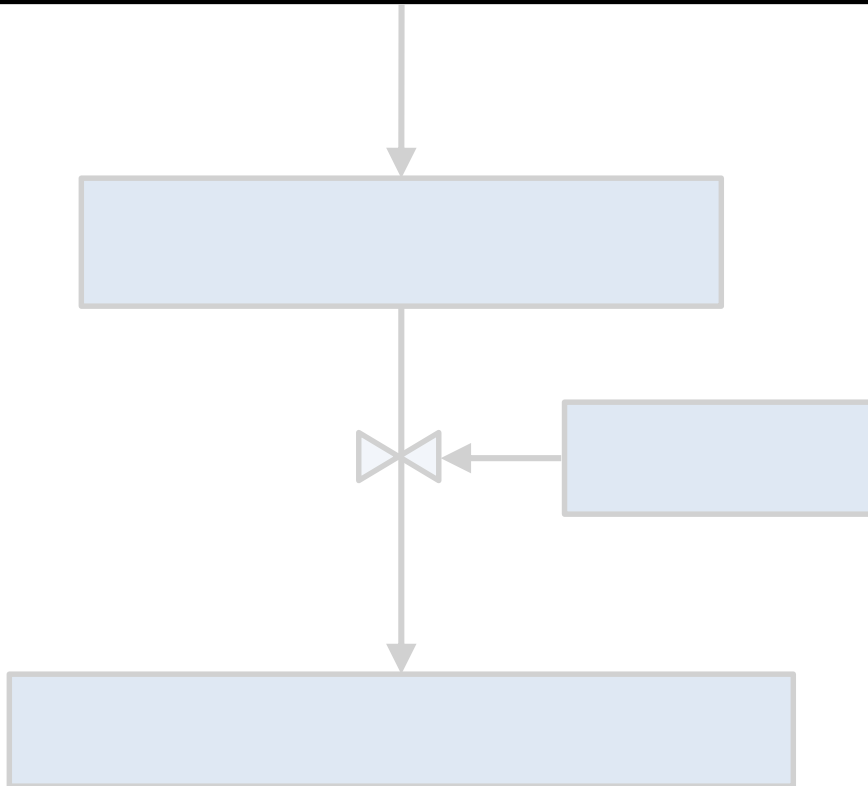
## Rangeland Water Pollutants of Concern

*nutrients, microbes, hormones, pharmaceuticals*

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Background &  
Other Sources

## • *Sources*



# *Cryptosporidium* in wildlife and livestock

Our research from the 1990-2000's

<b>Animal</b>	<b>% infected</b>
<b>Range beef cow</b>	<b>&lt; 5</b>
<b>Range beef calf &lt; 4 mo</b>	<b>10 - 20</b>
<b>Back country pack stock</b>	<b>0</b>
<b>Feral pig</b>	<b>4 - 13</b>
<b>Ground squirrel</b>	<b>7 - 15</b>



# *Cryptosporidium* species in Range Cattle

## Our research from 2010's

- Sampled 1412 cattle and calves across 20 ranches
- 14% positive for *Cryptosporidium* (same mean as before 👍 )
- Species identified in these cattle minimally infectious for humans
- The *Crypto* (and *Giardia*) in these cattle may not be a human risk.

<i>Cryptosporidium</i>	% cattle and calves
<i>C. parvum</i>	0%
<i>C. andersoni</i>	1%
<i>C. bovis</i>	24%
<i>C. ryanae</i>	75%

# *E. coli* O157:H7 Wildlife and Beef Cattle California's Central Coast Produce Region



*Who polluted the lettuce?*

## *E. coli* O157:H7

Feral pig	10/200	(5%)
Coyote	2/95	(2%)
Am. crow	5/93	(5%)
Cowbird	2/60	(3%)
Rabbit	0/108	(0%)
Skunk	0/63	(0%)
Tule elk	3/150	(2%)
Deer	0/447	(0%)
Rodents	2/1043	(0.2%)
Beef cattle	68/2715	(2.5%)

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• *Fate and Transport*

# Over 60% of cattle fecal loading is near livestock attractants in summer...

- Position salt, feed, water to attract cattle and pathogens to “safe” areas – not near streams or runoff areas



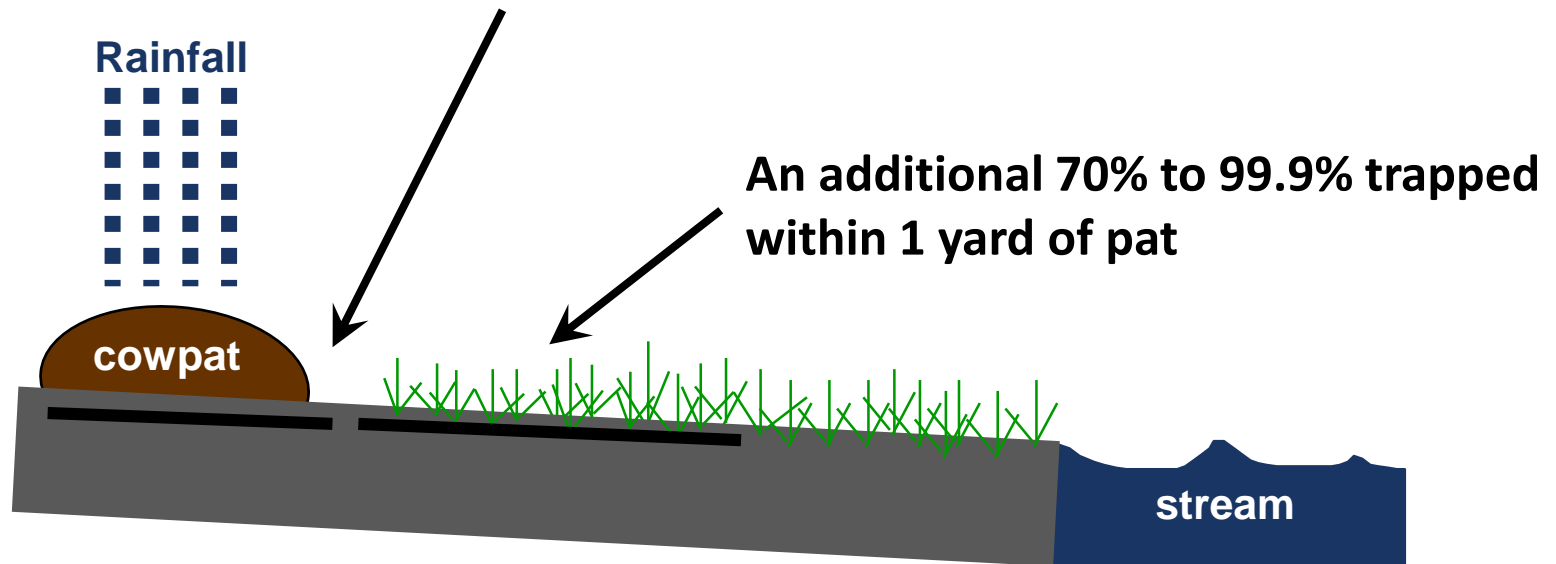
# *Crypto* Survival in Cow Pats on Rangeland

Temperature (F)		Days Until 99% <i>Crypto</i> Dead
Air	Fecal Pat in Sun	
64	86	5
78	104	<1

- *Crpto* oocysts in fecal pats excyst and die (false hatch).
- Remove cattle from sensitive areas (e.g., near drinking water lake) in Fall when still have warm days.
- Remove cattle from irrigated pasture 2 – 3 days before flood irrigation and tail water discharge.

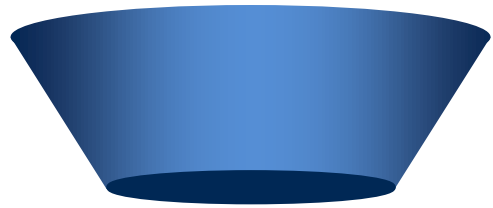
# Microbe Transport in Surface Runoff

**>90% of *Crypto* & *E. coli* & *Salmonella* & *Campy* & rotavirus retained in the fecal pat or trapped within 1 ft**



- Microbes are stuck in the pat, or attenuated in a very short distance down slope.

# Fate and Transport



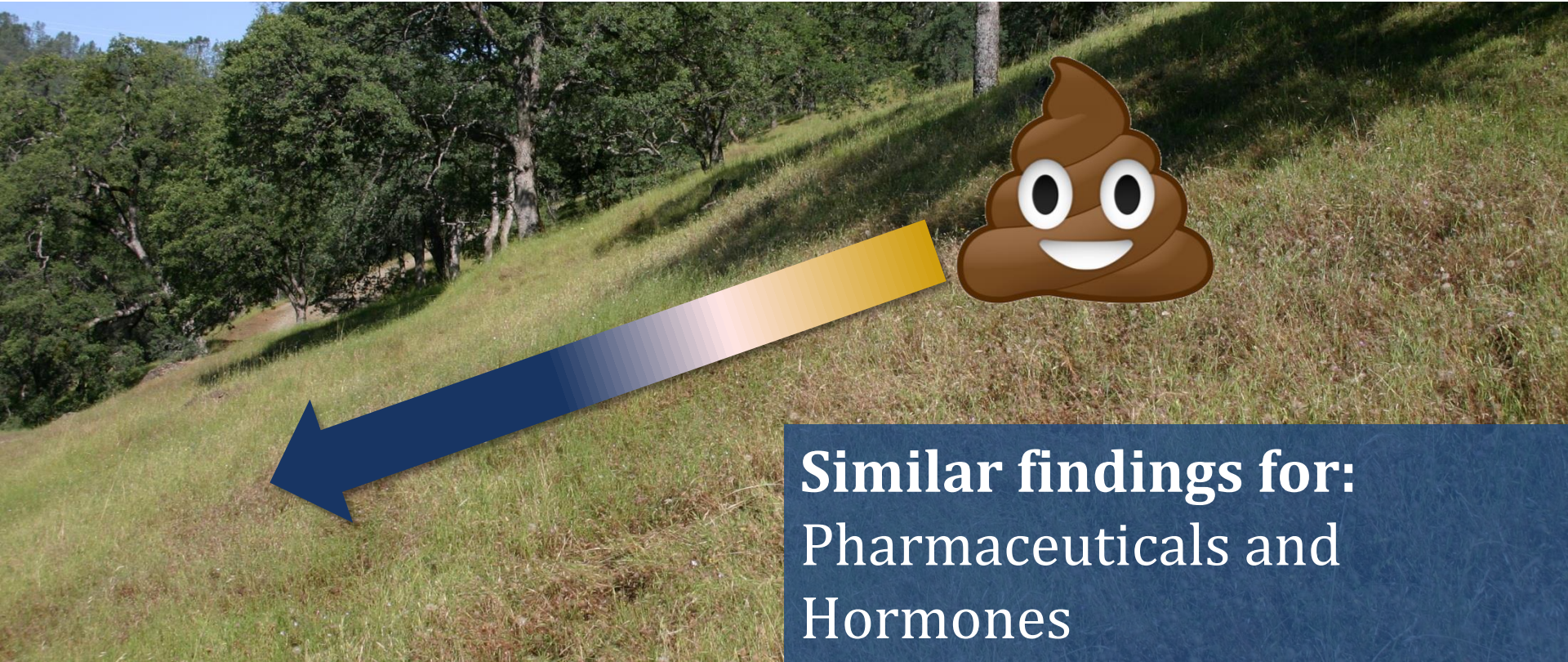
>90% of pollutants trapped at fecal pat



30-99% trapped each additional 1 yard



30-80% trapped in riparian areas



**Similar findings for:  
Pharmaceuticals and  
Hormones**

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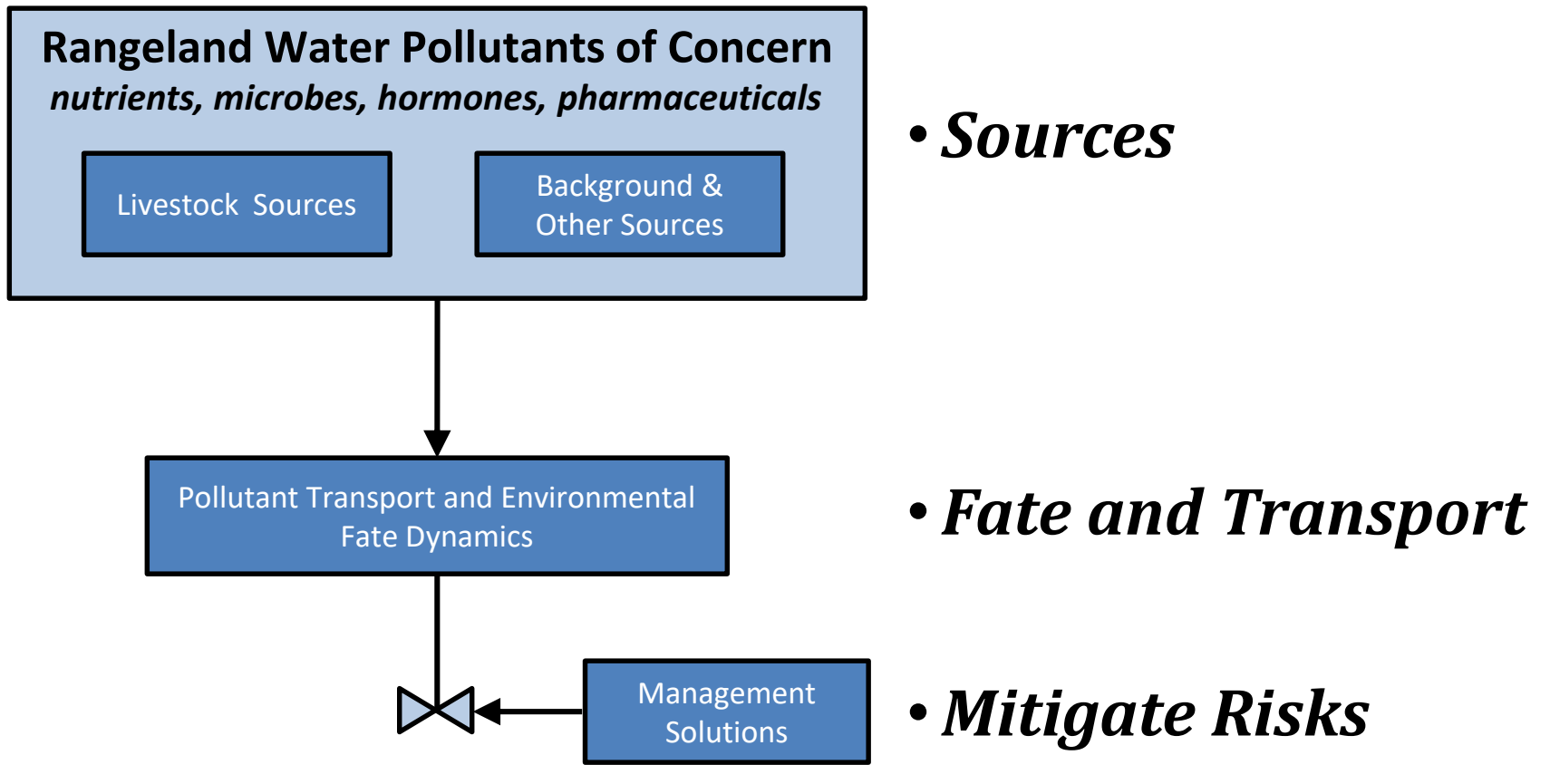
Pollutant Transport and Environmental  
Fate Dynamics

Management  
Solutions

• *Sources*

• *Fate and Transport*

• *Mitigate Risks*



# Range management that reduces pollution

## **Moderate stocking**

**Set stocking rate in balance with forage production and site resiliency to reduce impacts to soil and vegetation.**

## **Manage livestock distribution**

**Distribute livestock waste and associated pollutants across the landscape to increase microbe decay time and travel distance and upland attenuation.**

## **Manage riparian areas**

**Distribute livestock to resilient soils and uplands during saturated conditions, and manage riparian access and impact.**

# Range management that reduces pollution

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Distribute livestock waste and associated pollutants across the landscape to increase microbe decay time and travel distance and upland attenuation.

## Manage riparian areas

Distribute livestock to resilient soils and uplands during saturated conditions, and manage riparian access and impact.

- rest and rotational grazing
- cross fencing
- riparian pastures
- off-stream drinking water
- targeted suppl. feeding
- herding
- vegetative buffer strips
- healthy riparian areas



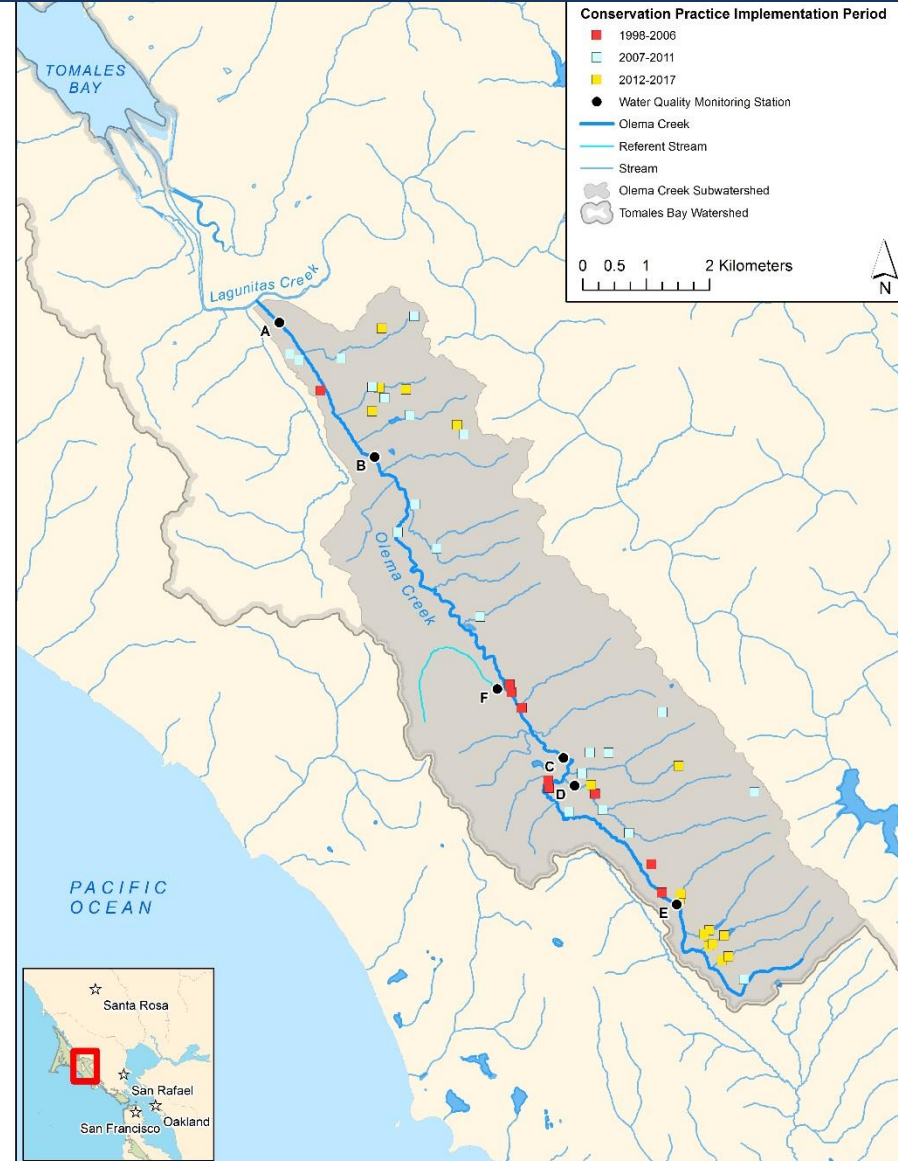
# Pt. Reyes National Seashore

## *Case Study*



# Case Study: Olema Creek Riparian Restoration, Pt. Reyes National Seashore

- History of elevated microbial pollution.
- Impairment aquatic habitat and stream health.
- Unmanaged livestock access to stream.

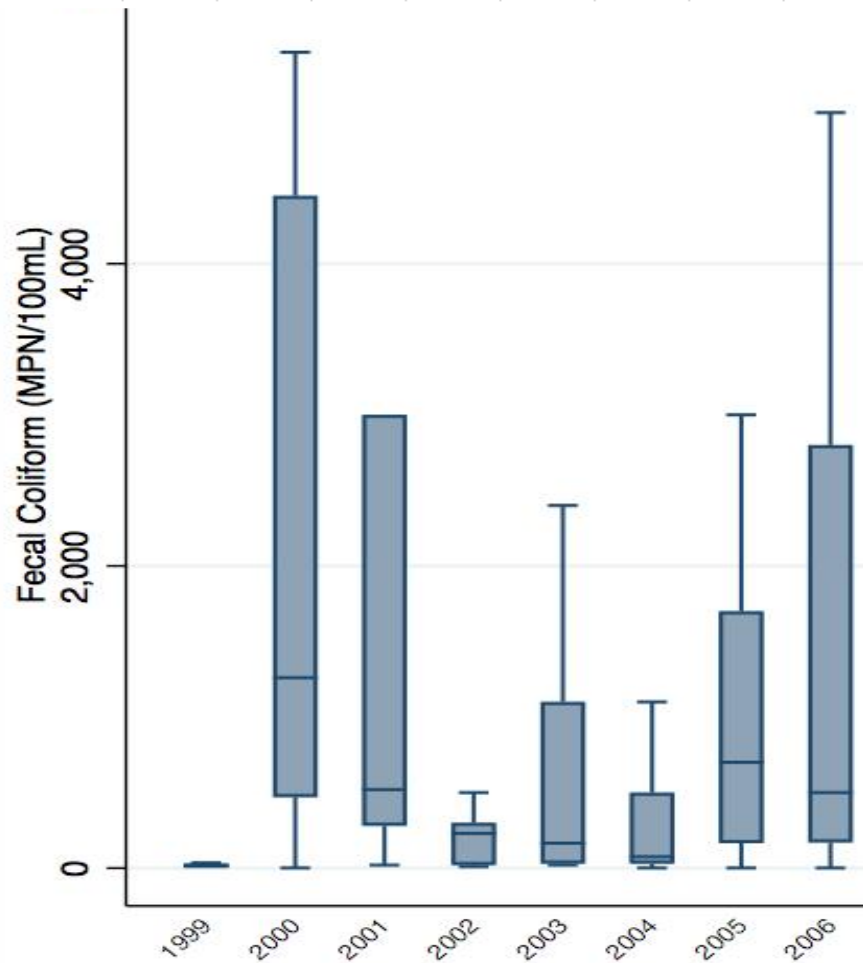


# Case Study: Olema Creek Riparian Restoration, Pt. Reyes National Seashore

1999 → 2006

9 Conservation Practices  
4.16 Stream KM Influenced

Sites	3	3	4	4	5	5	5	5
Samples	7	12	17	12	27	77	100	88



# Case Study: Olema Creek Riparian Restoration, Pt. Reyes National Seashore

- A campaign of management improvements and monitoring
- NPS, ranchers, EPA & water boards, NRCS, RCDs, UCCE, etc.
- Planning, permitting, funding, implementation, monitoring.

**riparian fencing**

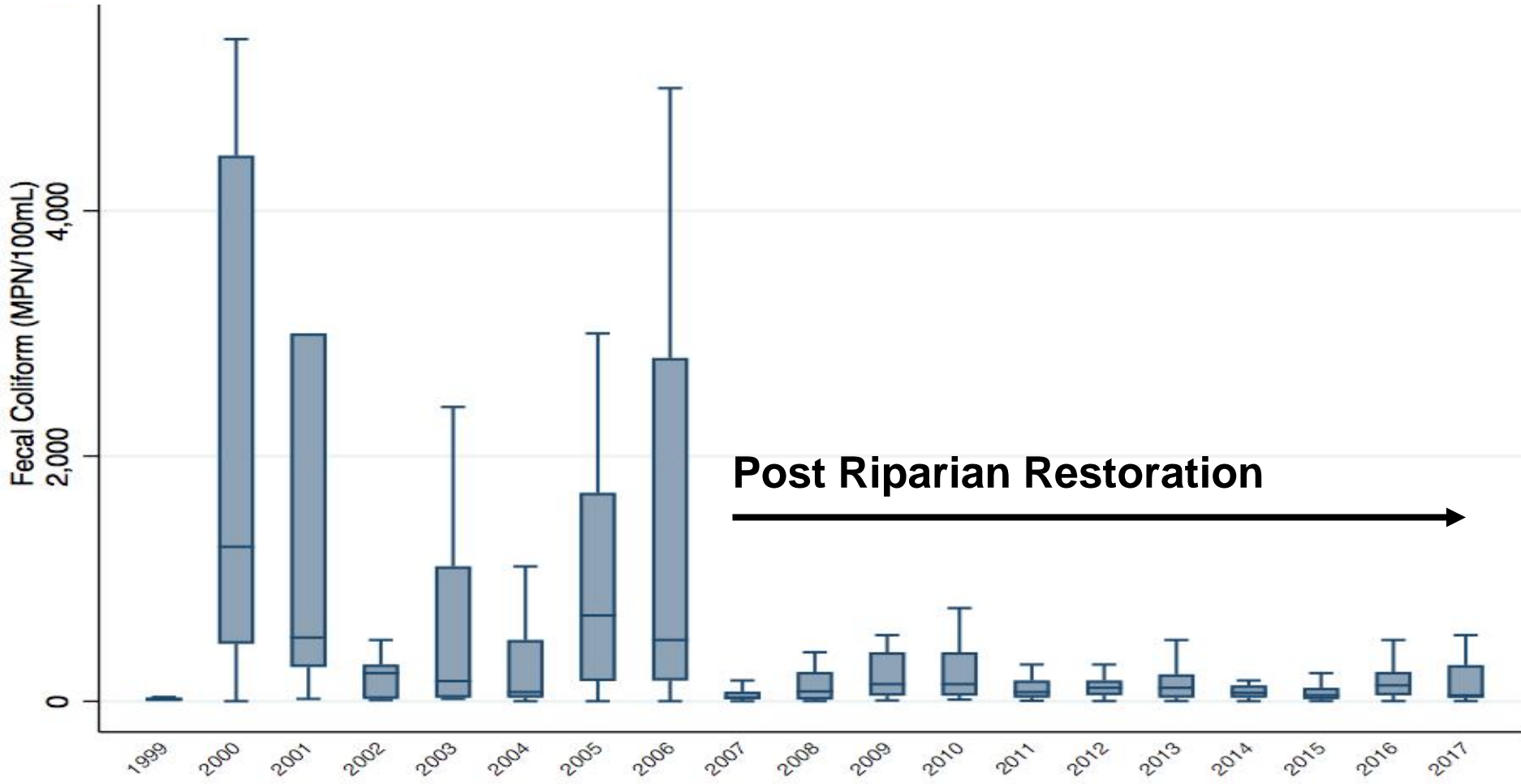
**stream crossing**

**off-stream drinking**



# Case Study: Olema Creek Riparian Restoration, Pt. Reyes National Seashore

	1999 → 2006								2007 → 2011					2012 → 2017					
	9 Conservation Practices 4.16 Stream KM Influenced								21 Conservation Practices 15.64 Stream KM Influenced					16 Conservation Practices 8.56 Stream KM Influenced					
<b>Sites</b>	3	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
<b>Samples</b>	7	12	17	12	27	77	100	88	50	25	82	70	70	87	60	25	74	79	91







For Immediate Release, November 21, 2017

## **Cattle Waste Puts California's Point Reyes on 'Crappiest Places in America' List**

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# Summary

- Management can certainly create risk to water quality, or it can protect water quality.
- Rangelands have great capacity to attenuate pollutants from livestock and other ranch activities – work with that potential.
- A large toolbox of tested, feasible practices exists that can be used to keep water quality high on grazing lands.
- 25 years of cooperative education, management, and research.

# Grazing Management for Healthy Soils

The screenshot shows the website for the California Department of Food and Agriculture (CDFA). At the top left is the CA.GOV logo. The main header reads "CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE". To the right is a search bar with a magnifying glass icon and radio buttons for "This Site" (selected) and "California". Below the header is a navigation menu with buttons for Home, Divisions, Customer Service, Meetings, News, Jobs, Laws/Regs, Statistics, and Publications. A secondary navigation bar includes links for Find Subject, Programs & Services, Public Meetings, Site Map, FAQs, Contact Us, About CDFA, and Español. The main content area features a background image of a green field with trees in the distance. Overlaid on this image is the text "THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION" and a large logo for the "healthy soils program" which consists of a stylized plant growing from a hand. Below the main content, there is a breadcrumb trail: "CDFA Home > Office of Environmental Farming and Innovation > Healthy Soils Program". On the left side of the lower section, the text "HEALTHY SOILS PROGRAM" is displayed. On the right side, there is a yellow button labeled "EMAIL SUBSCRIPTIONS" and a light blue box containing the text "Sign up for email notification".

CA.GOV

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

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THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION

 **healthy soils program**

CDFA Home > Office of Environmental Farming and Innovation > Healthy Soils Program

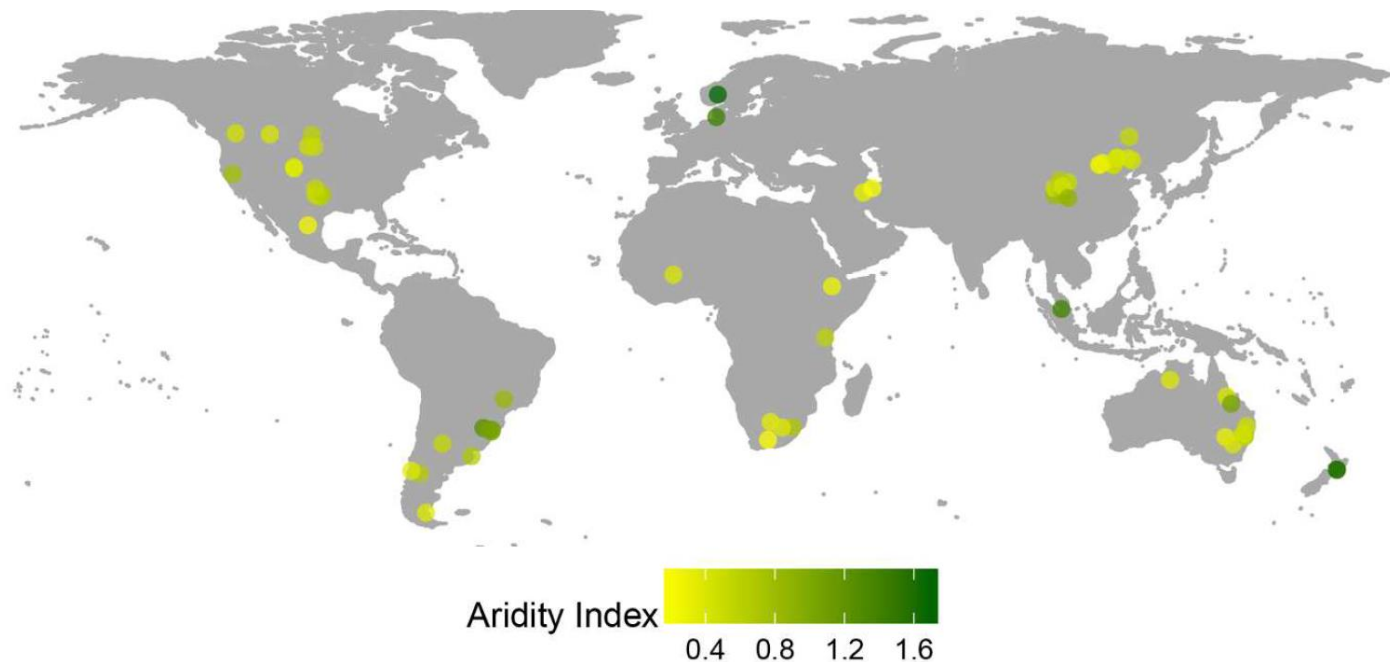
**HEALTHY SOILS PROGRAM**

**EMAIL SUBSCRIPTIONS**

Sign up for email notification

# What do we know about how grazing management impacts soil health?

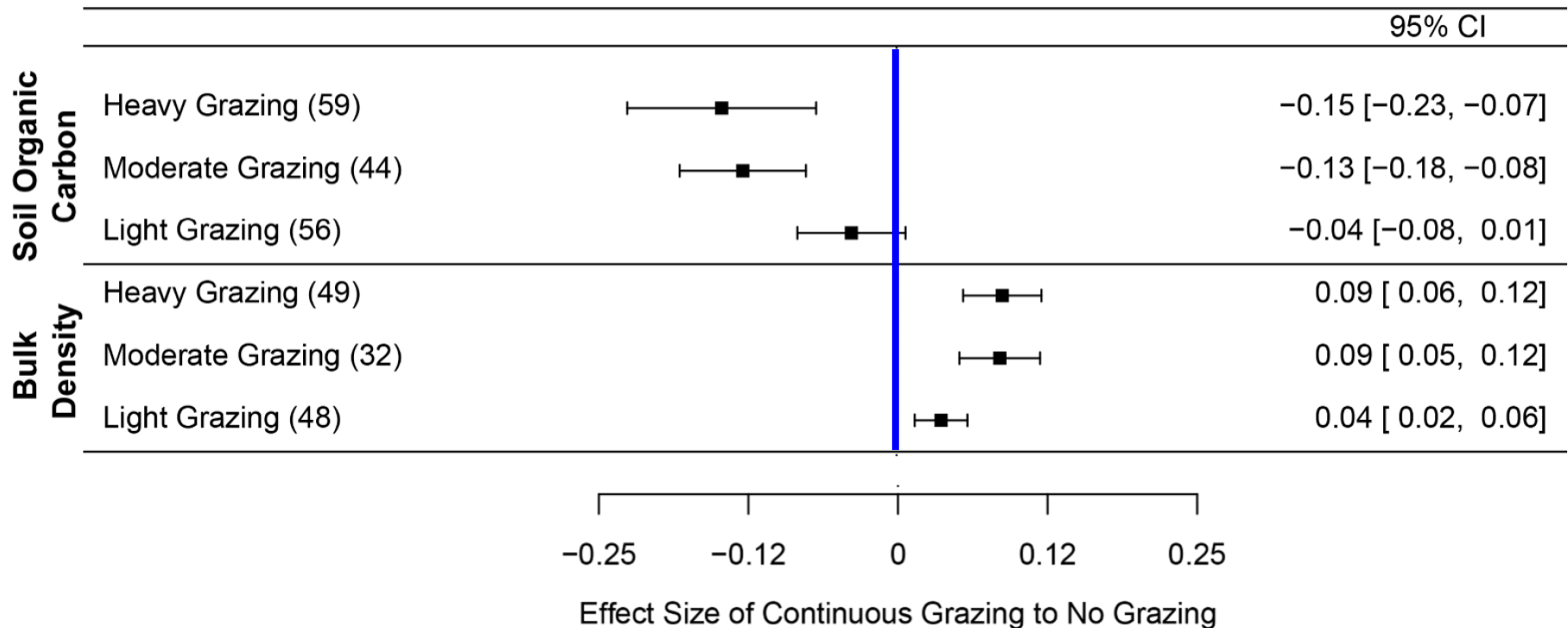
Byrnes, R.C., D.J. Eastburn, K.W. Tate, and L.M. Roche. 2018. *A Global Meta-Analysis of Grazing Impacts on Soil Health Indicators*. *J. Environmental Quality*.



# Does Stocking Rate (Grazing Intensity) Impact Soil Health?

On average, increased grazing intensity...

1. reduces carbon
2. increases compaction



# Does Stocking Rate (Grazing Intensity) Impact Soil Health?

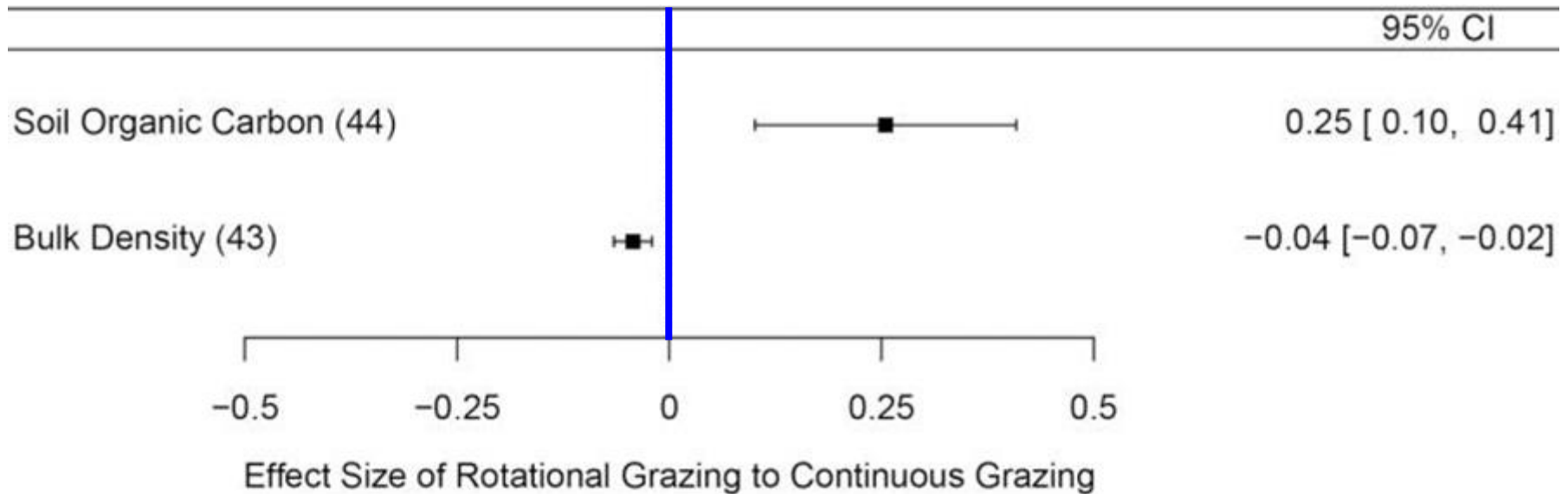
Soil properties such as texture dictate *resilience* to compaction and subsequent...

Soil Texture	Resistance to Compaction
Sand	++
Loam	+
Silt Loam	-
Clay	--

# Does Rotation Improve Soil Health over Continuous Grazing?

Compared to continuous grazing, rotational grazing results in:

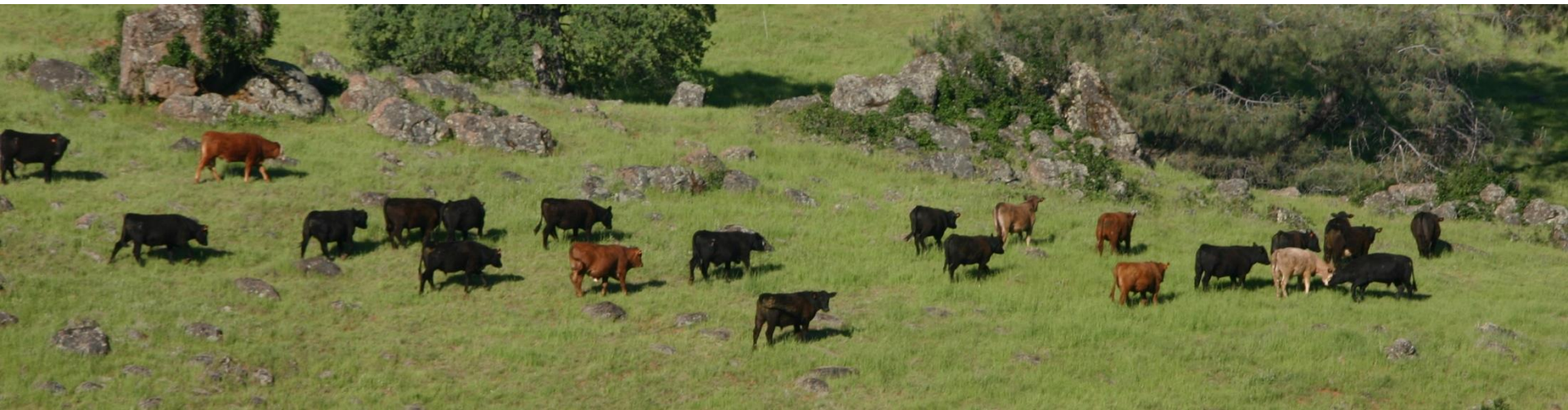
- Increased carbon.
- Decreased soil compaction.



# How can grazing management maintain/improve soil health?

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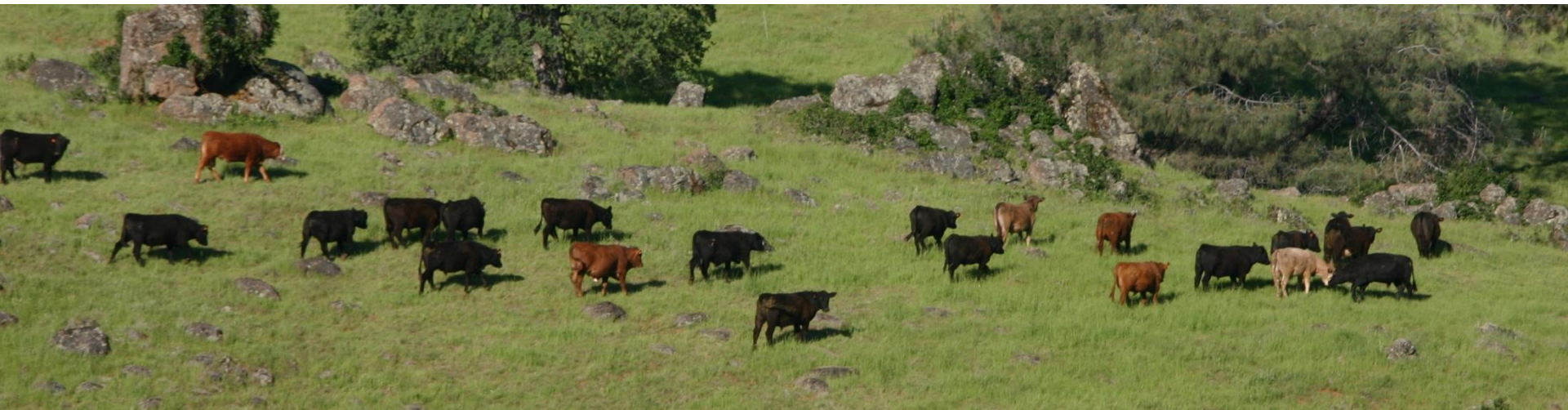
1. Grazing must not create soil compaction which functionally limits root and water penetration of the entire soil profile.



# How can grazing management maintain/improve soil health?

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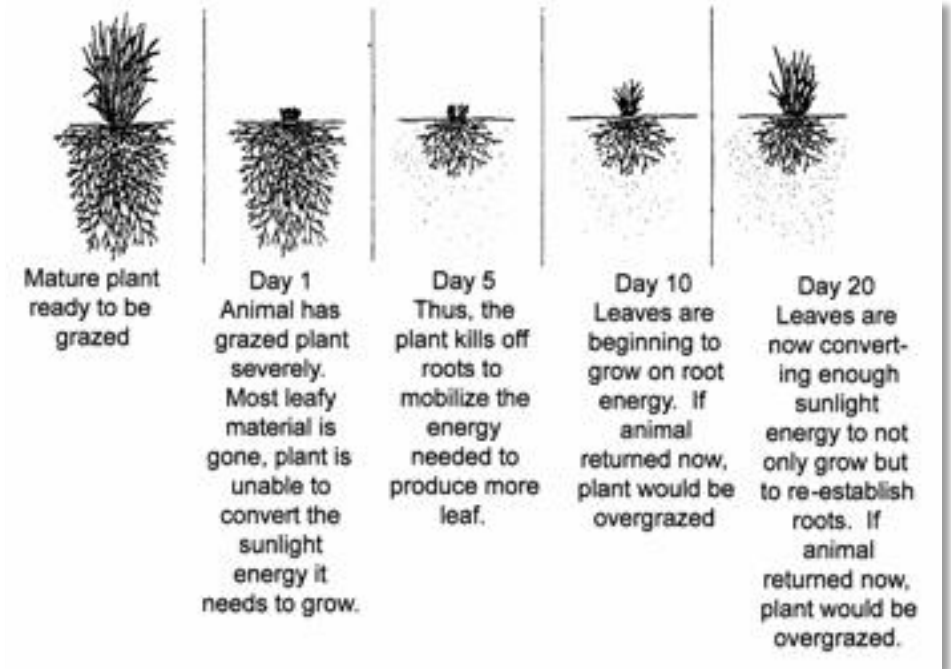
1. Grazing must not create soil compaction which functionally limits root and water penetration of the entire soil profile.
2. Grazing must not reduce plant vigor and capacity to fully develop rooting system (mass and depth in soil).



# Rangeland Ecology and Management

## Rangeland Ecosystems – Grazing Management to Sequester Carbon

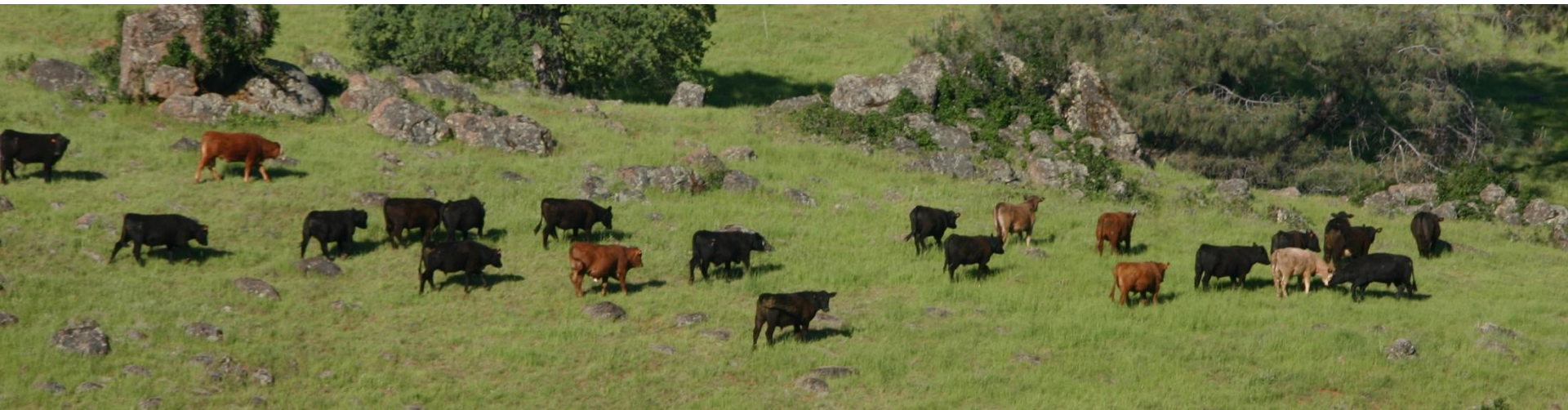
Satisfies the needs of the grazed plants for regrowth of leaf area and root mass, vigor, competition...



# How can grazing management maintain/improve soil health?

---

1. Grazing must not create soil compaction which functionally limits root and water penetration of the entire soil profile.
2. Grazing must not reduce plant vigor and capacity to fully develop rooting system (mass and depth in soil).
3. Optimize plant production (above and below ground).

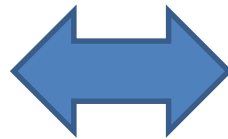
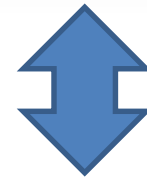
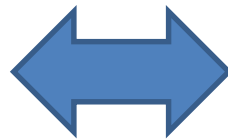




## **There is not one perfect prescription...**

- Stocking rates must match carrying capacity, and be adjusted with seasonal and annual conditions as needed.
- Continuous, season-long, moderately stocked strategies can and do sustain soil, forage, water, and livestock gains.
- Extensive rotational strategies are common among working ranches – likely for good reasons.
- Intensive rotational strategies must include adequate rest for plant recovery from high stock densities.

# Healthy soils, forage and livestock production, profitability, and clean water are interconnected...



# UC RANGELANDS

*Supporting Working Landscapes*

[rangelands.ucdavis.edu](http://rangelands.ucdavis.edu)



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