

Best Management Practices at the Ranch to Minimize Pathogen Loading

Ken Tate, Rob Atwill, and a bunch of characters – UC Davis



Today

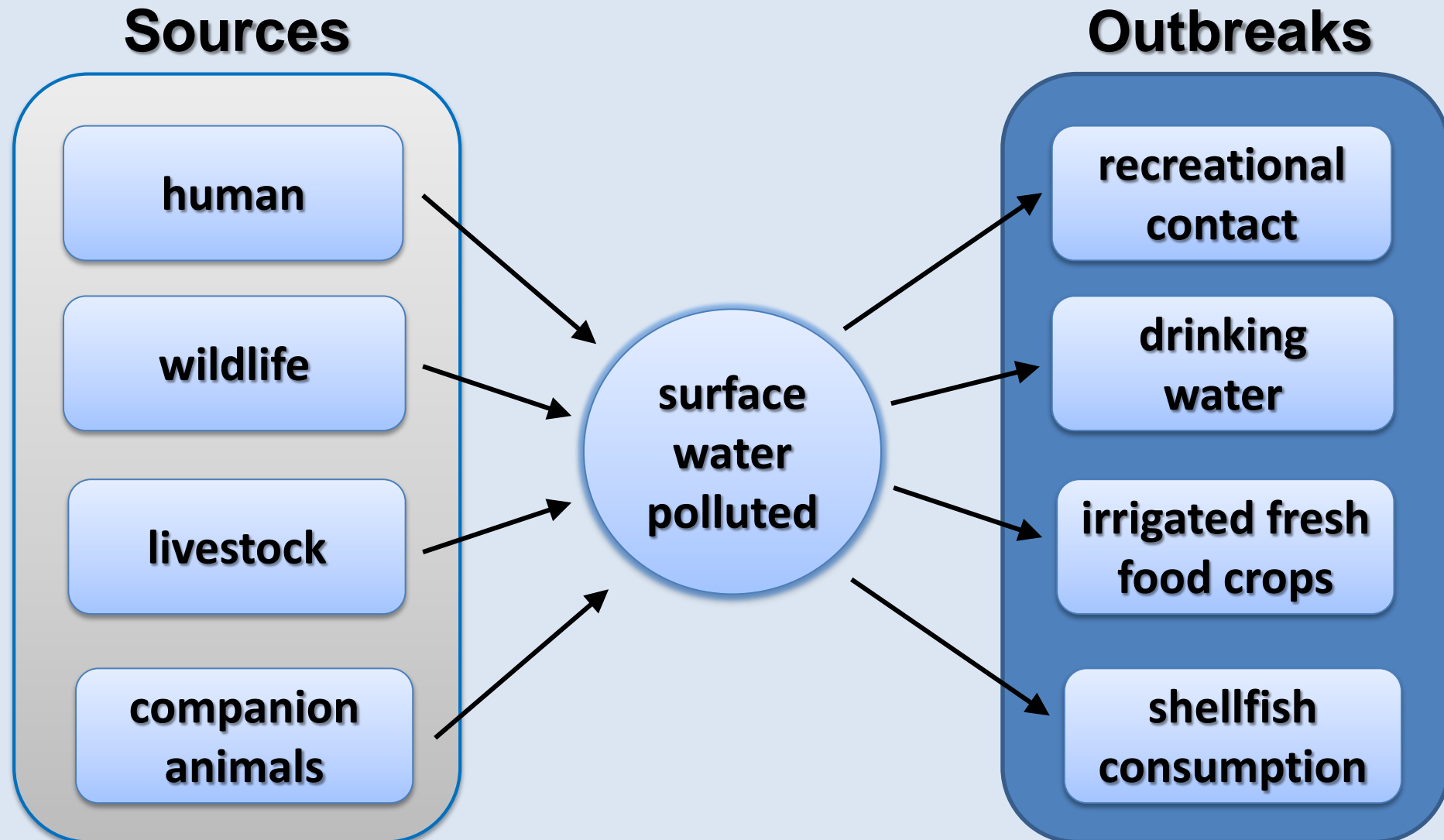
The growing body of research on microbial WQ on California grazed watersheds.

- *Who are these microbes?*
- *Where do they come from?*
- *Where do they end up?*
- *How to manage risk?*



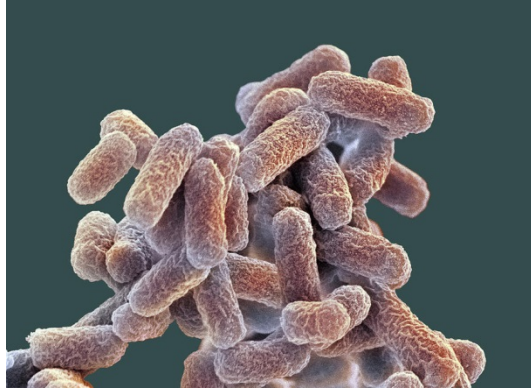
Microbial Water Quality & Grazed Watersheds

The Big Picture

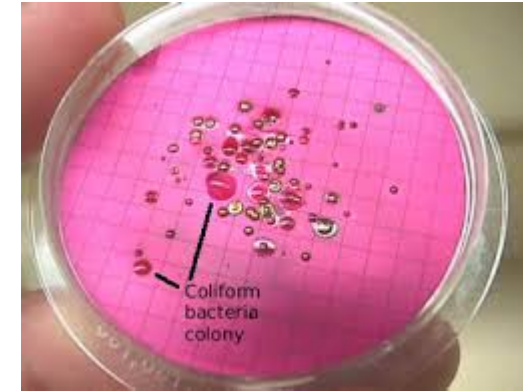


Microbial Pollutants

Indicators



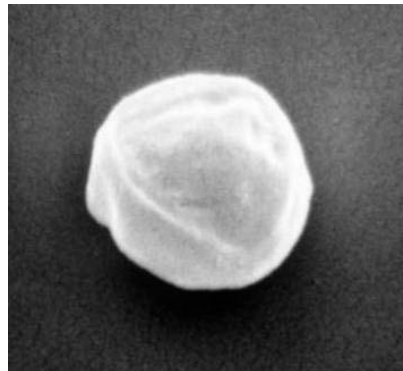
Fecal coliforms
Indicator *E. coli*



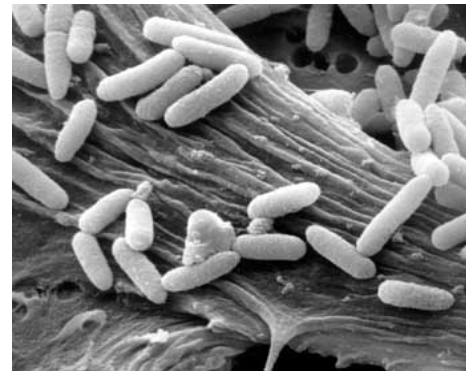
Bacteria that when present in water **indicate** the presence of fecal material and pathogens.

We hope!

Pathogens



C. parvum



E. Coli O157:H7



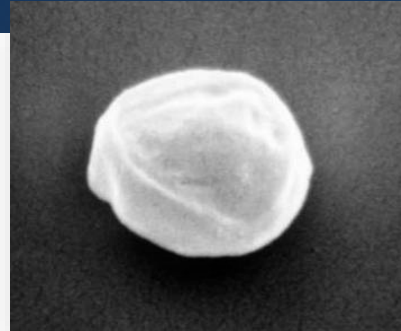
Salmonella

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

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 California 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.

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

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 (left) is the spore marmosets, especially calves. Of banning cattle — or maybe just the Los Vaqueros watershed? — of contracting cryptosporidiosis, but the district doesn't want to

Francisco water district targets cattle

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



THE TIMES • MONDAY, MARCH 24, 1997 • LOCAL

Water district backs away from cattle grazing ban around lake

By DENIS CUFF

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 waterways 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 shoddies of crypto, by eliminating them, we can control the risk," said John Steere, a district watershed planner. "This

RECOMMENDATIONS

district would install fencing to keep

Francisco water district targets cattle

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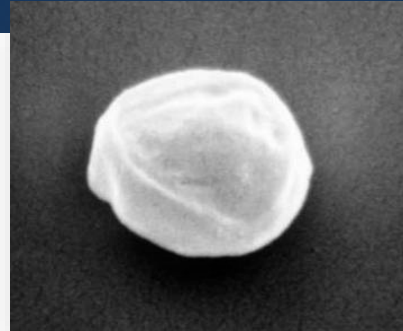
ness (cryptosporidiosis) lasts only a few days in most people with healthy immune systems, but

1997 Bay Area – *Cryptosporidium*

Livestock



Pathogens



C. parvum



Drinking Water



“You need the results today?”

We just started the studies yesterday!”

Assistant Specialists Atwill and Tate, 1997

Ongoing Research at the Time

How do cattle distribute fecal deposits (and thus microbes) across rangeland in space and time? Can we predict it?



A Comparative Method for Estimating Cattle Fecal Deposition on Rangeland Watersheds. JRM, 2000

Spatial and Temporal Patterns of Cattle Feces Deposition on Rangeland. JRM, 2003



It's a dirty job!



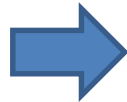
Ongoing Research at the Time

How quickly do pathogens die in fecal pats? Does it depend on temperature?

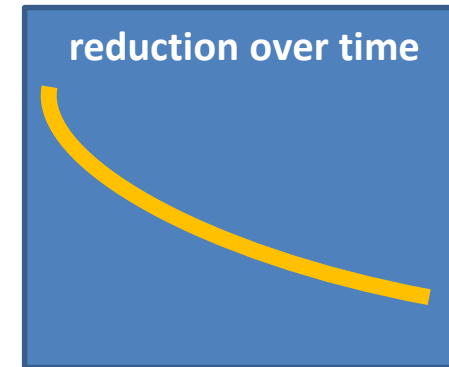
It's an even dirtier job...



Temp. logger



Put it into a juicy bovine fecal fat



Develop microbe decay curve

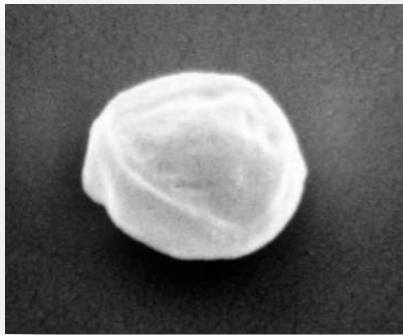
Seasonal Temperature Fluctuation Induces Rapid Inactivation of Cryptosporidium parvum. Environmental Science and Technology, 2005

Effect of Daily Temperature Fluctuation during the Cool Season on the Infectivity of Cryptosporidium parvum. Applied and Environmental Microbiology, 2005

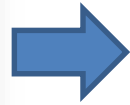
Ongoing Research at the Time

How are pathogens mobilized from fecal pats during rainfall-runoff events? How far will they travel in runoff?

It's the dirty job!



C. parvum



Stir it into a juicy bovine fecal pat



Dose a runoff plot, and rain on it

Transport of Cryptosporidium parvum Oocysts through Vegetated Buffer Strips and Estimated Filtration Efficiency. Applied and Environmental Microbiology, 2002.

Efficacy of Vegetated Buffer Strips for Retaining Cryptosporidium parvum. J. Environmental Quality, 2004.

Ongoing Research at the Time



Efficacy of Natural Grass Buffers for Removal of Cryptosporidium parvum in Rangeland Runoff. J. Food Protection, 2006.

Significant E. coli Attenuation by Vegetative Buffers on Annual Grasslands. J. Environmental Quality, 2006.

Ongoing Research at the Time

Microbial WQ responses to watershed scale grazing treatments (e.g., none v. moderate v. heavy grazing)?



Nitrate and Sediment Fluxes from a California Rangeland Watershed. J. Environmental Quality, 2006.

Watershed Research Examines Rangeland Management Effects on Water Quality. California Agriculture, 2001.

Hydrology in a California Oak Woodland Watershed: a 17-Year Study. J. Hydrology, 2000.

Ongoing Research at the Time

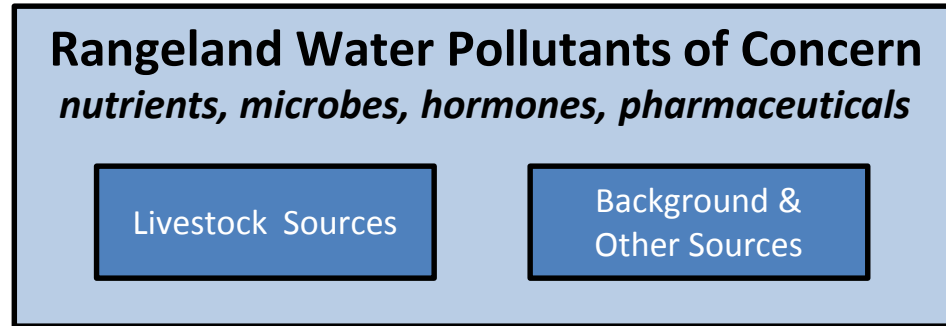
Methods development in the field and laboratory (systems-scale study designs & stats, improved detection, safer).



Improved Quantitative Estimates of Low Environmental Loading and Sporadic Periparturient Shedding of Cryptosporidium parvum in Adult Beef Cattle. Applied and Environmental Microbiology, 2003.

A Relational Database for the Monitoring and Analysis of Watershed Hydrologic Functions: II. Data Manipulation and Retrieval Programs. Computers and Geosciences, 2005.

The Line of Research



• *Sources*

Cryptosporidium in wildlife and livestock

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



The Key New Finding

New statewide herd survey of range cattle and calves – 14% had Cryptosporidium.

Cryptosporidium	No. Observations
<i>C. ryanae</i>	61/81 (75%)
<i>C. bovis</i>	19/81 (24%)
<i>C. andersoni</i>	1/81 (1%)
<i>C. parvum</i>	0/81 (0%)

- Species and subtypes identified in cattle are minimally infectious for humans.
- Protozoal contamination by cattle may not be the public health threat once thought.

K. Flores *et al.*

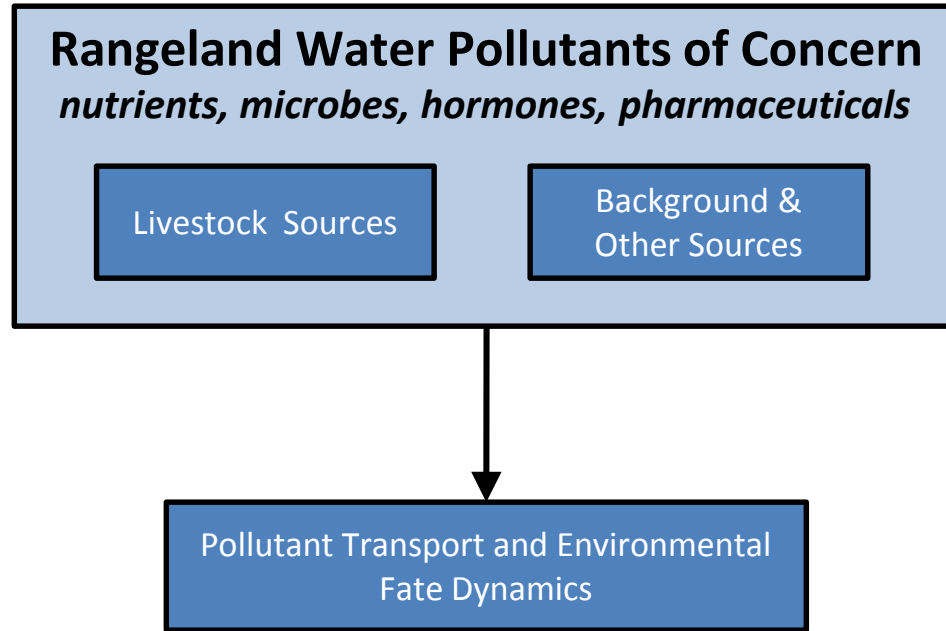
Prevalence of *E. coli* O157:H7 Wildlife and Beef Cattle CA Central Coast



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%)

The Line of Research



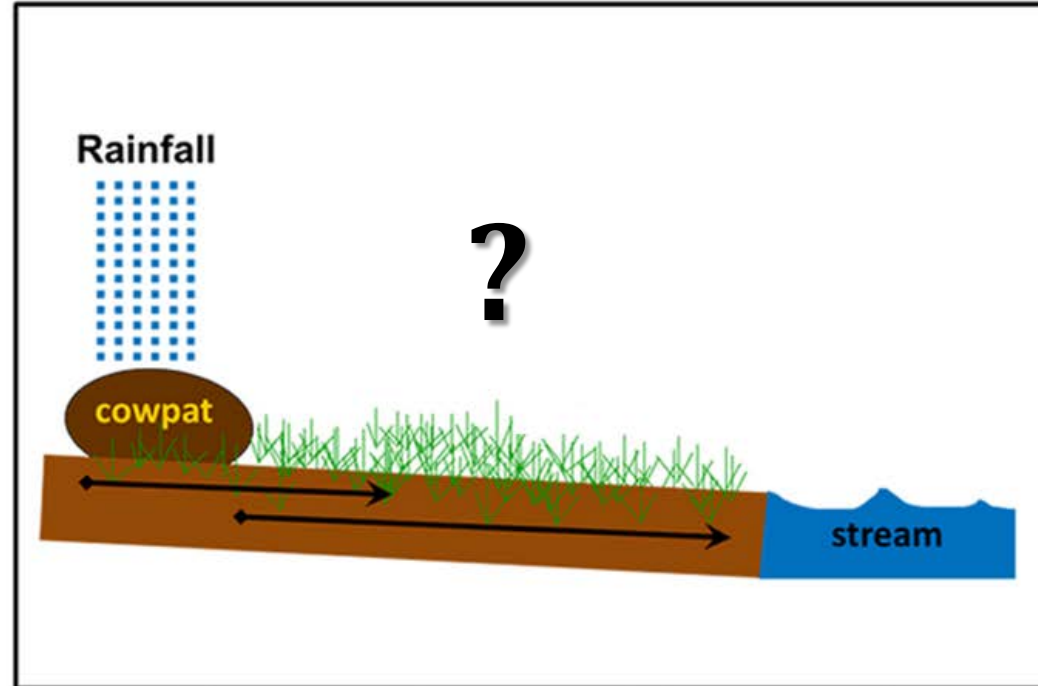
• *Sources*

• *Fate and Transport*

Fate of Microbial Pollutants on Rangelands

How long do FIB and pathogens survive in fecal pats, water, soil?

How are FIB and pathogens released and transported from fecal pats?



Crypto survival in cow pats on range

Fecal Pat Temperature (F)	Days Until >90% Dead
50	72
68	29
86	5
104	<1

- Once temperature in a cow fecal pat $> 104^{\circ}\text{F}$ all the *C. parvum* in that pat dies.
- Fecal pats in direct sun achieve 104°F once air temperature reaches 78°F .

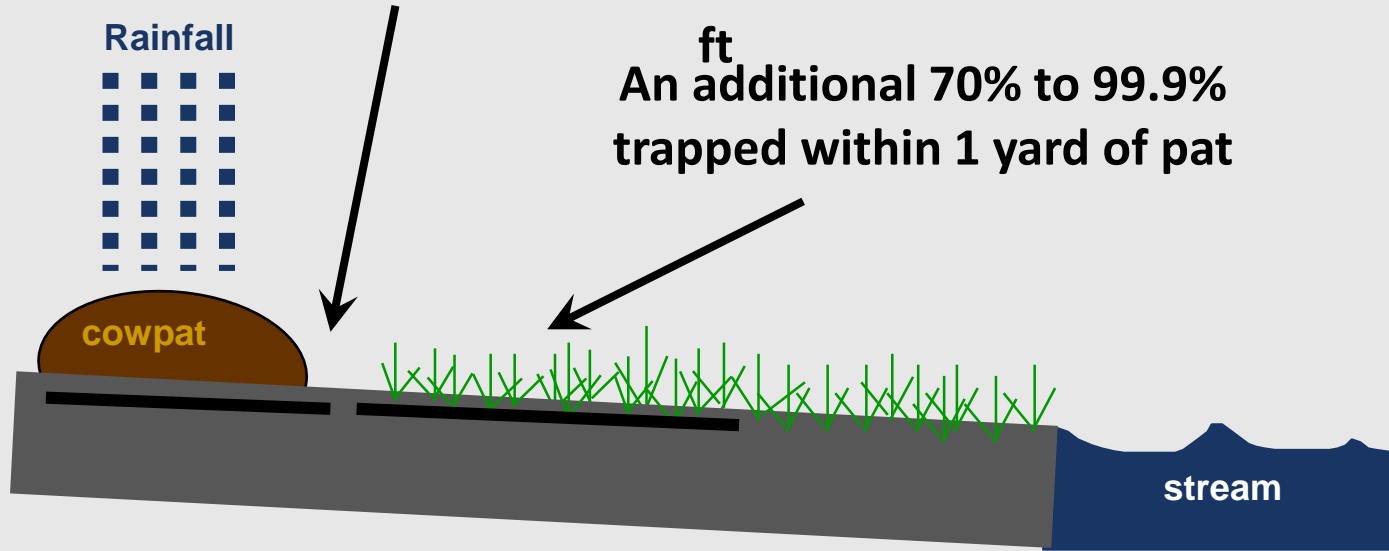
Crypto transport w/ rainfall-runoff

>90% of *C. parvum* & *E. coli* retained in the fecal pat or trapped within 1

Rainfall

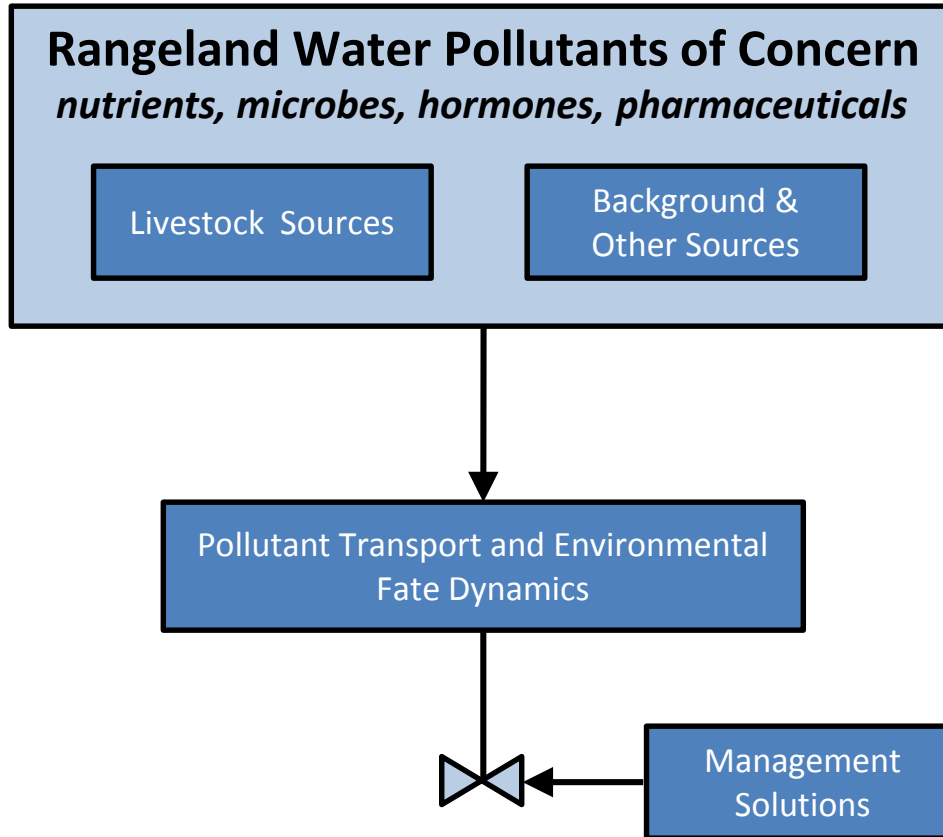


cowpat



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

The Line of Research



• *Sources*

• *Fate and Transport*

• *Mitigate Risks*

Grazing Intensity

Indicator *E. coli*

No Grazing

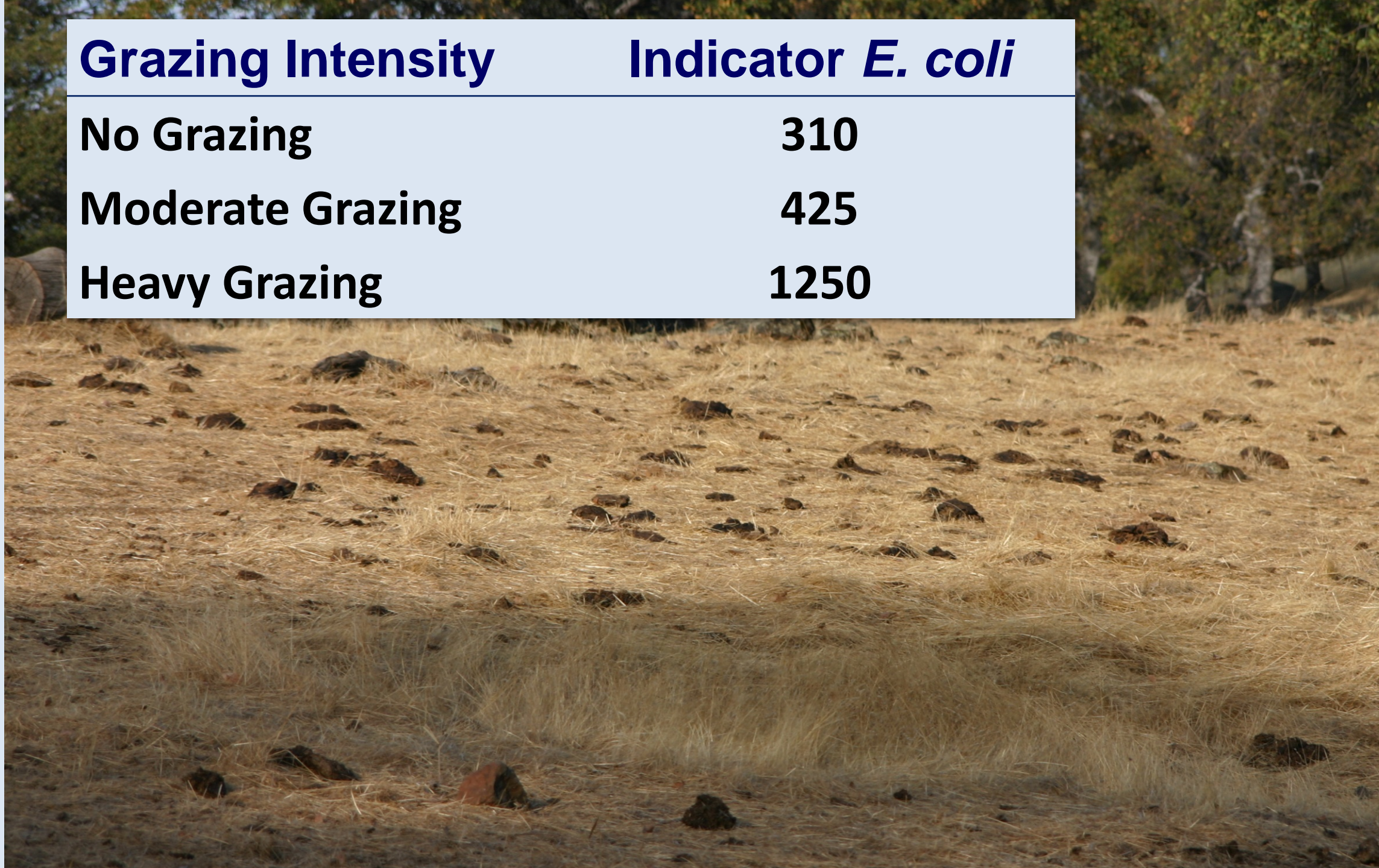
310

Moderate Grazing

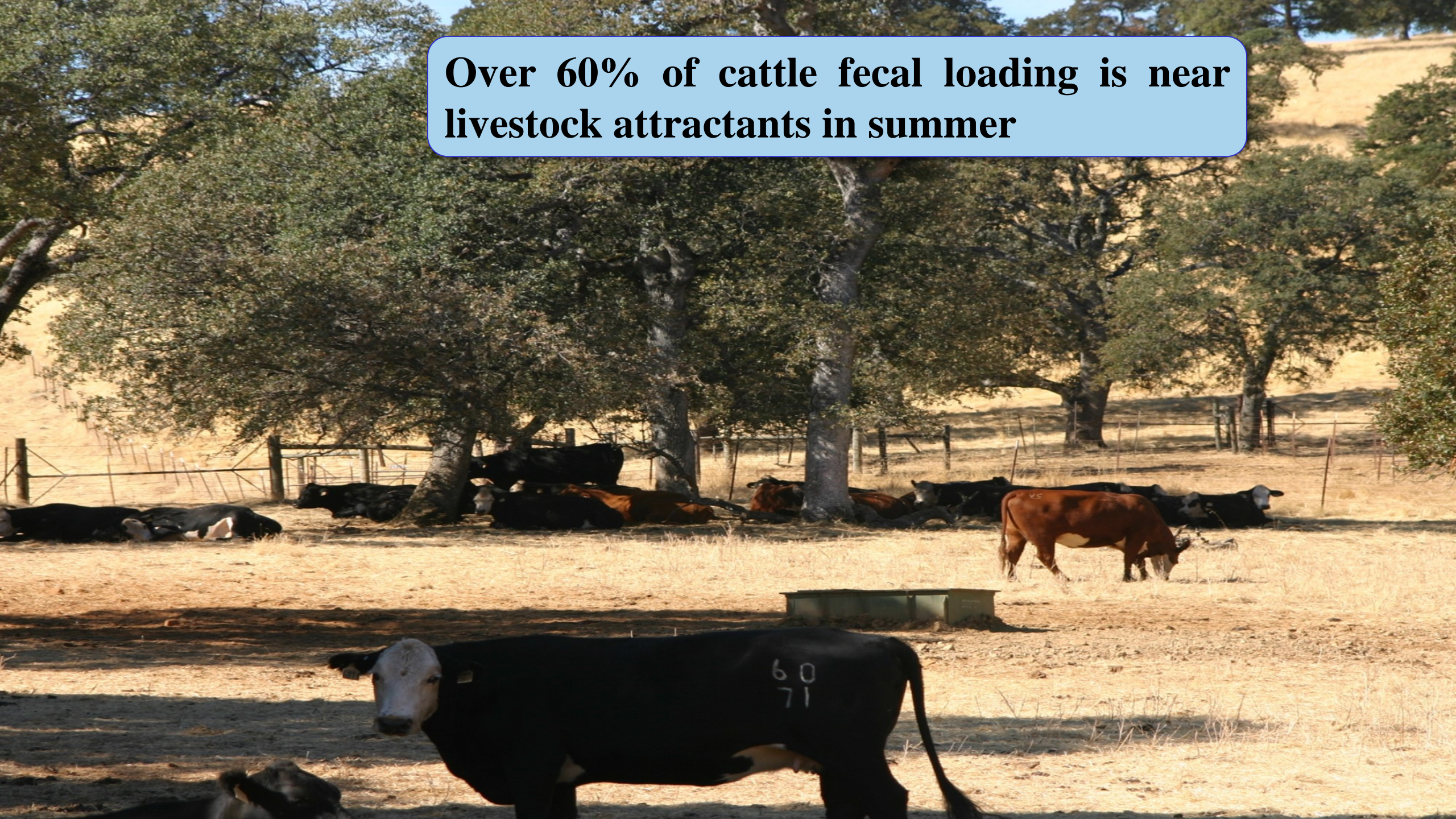
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Heavy Grazing

1250



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

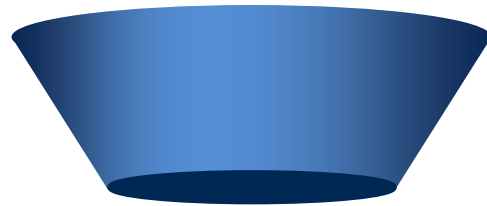


Do you know where is your supplement is?

- Move existing supplement and water sites out of near-stream locations.
- Evaluate trails leading to and from existing and proposed sites – do they link site to surface water?



The whole range is a microbial filter...



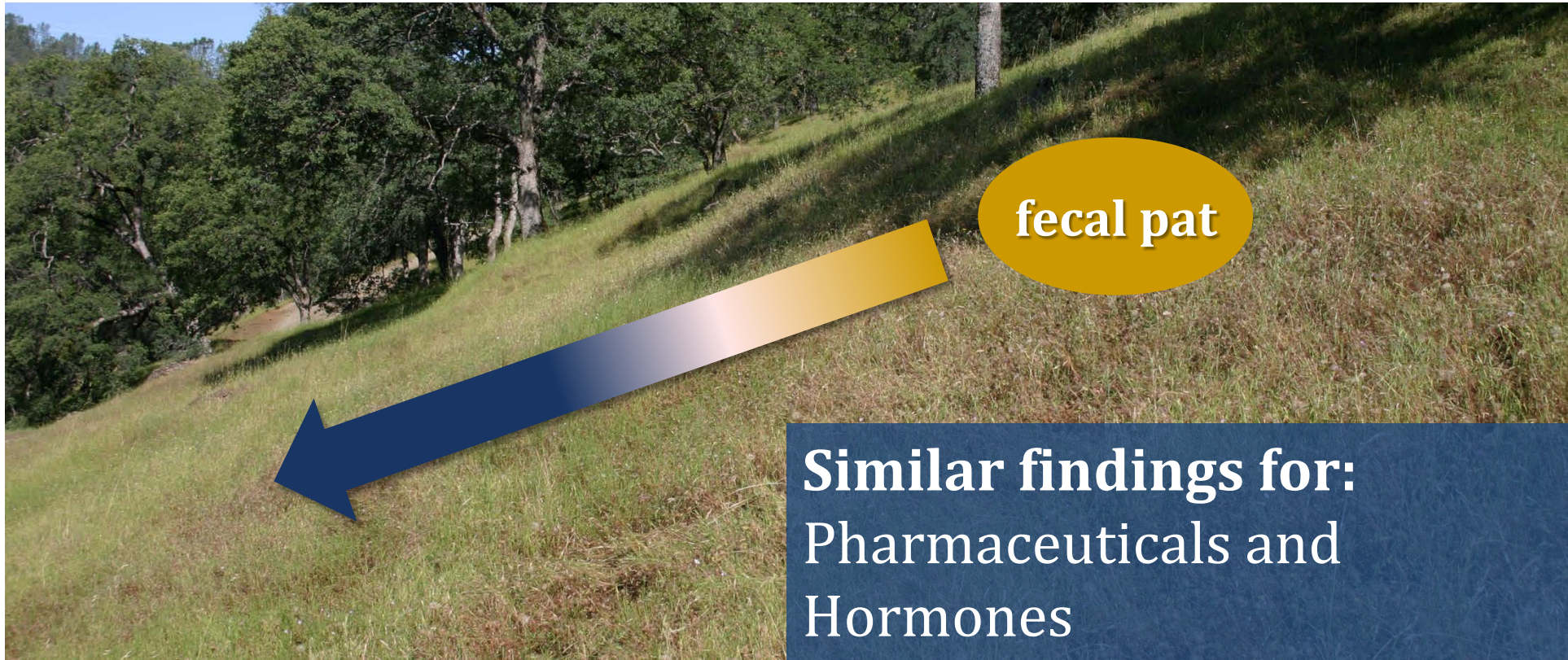
>90% of pollutants trapped at fecal pat



70-99% trapped each additional 1 yard



30-70% trapped in riparian areas



fecal pat

**Similar findings for:
Pharmaceuticals and
Hormones**

Range management that reduces water pollution risk

Moderate stocking

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

Manage livestock distribution

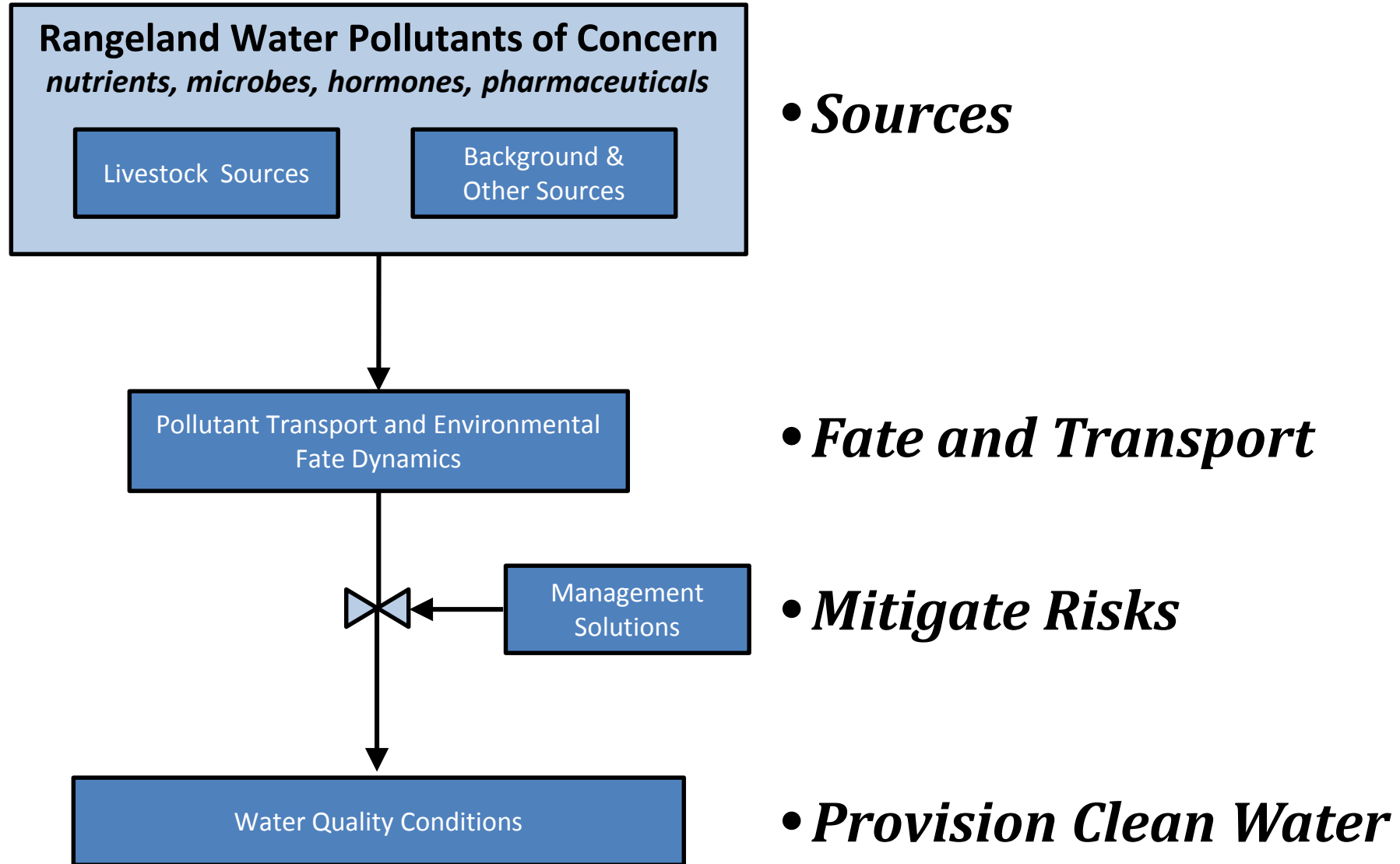
Distribute grazing and waste across the landscape, and actively manage grazing intensity in critical hydrologic zones.

Manage wet season

Distribute livestock to resilient soils and non-critical hydrologic zones during saturated conditions.

Prescribed grazing, cross fencing, off-stream drinking water, targeted supplemental feeding, riparian pastures, herding, vegetative buffer strips

The Line of Research

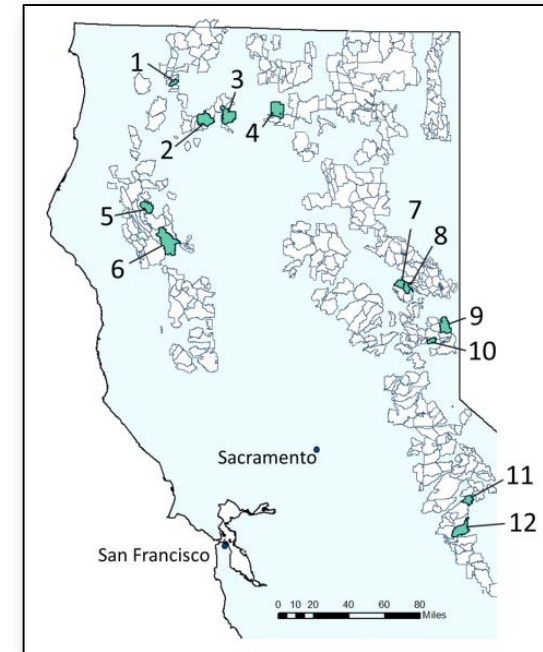


Public Lands Grazing & Water Quality

Cross-sectional, Longitudinal Survey

12 USFS grazing allotments, 5 National Forests

- Nutrients below levels of ecological concern, and similar to background estimates.
- Mean concentrations below US EPA *E. coli* benchmarks.
- Met US EPA *E. coli* benchmarks for >94% of samples collected and >83% of sites.

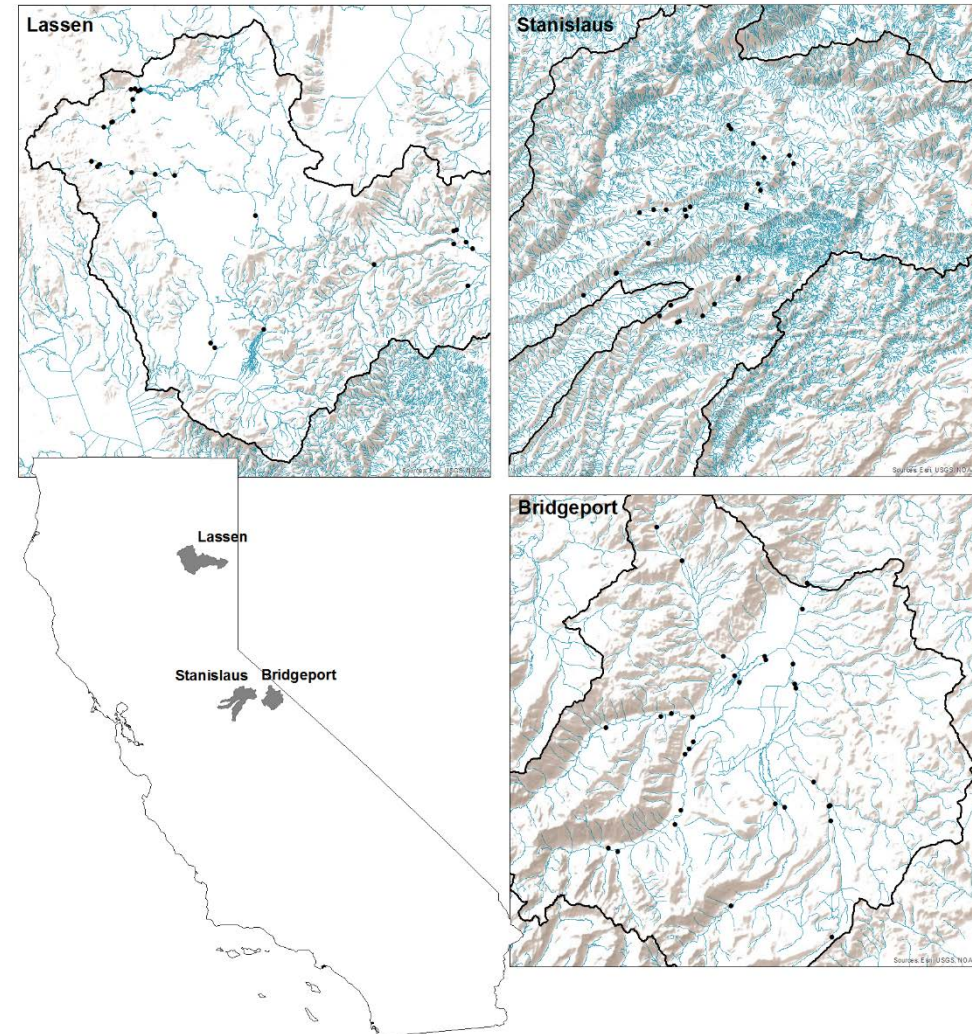


Water Quality Conditions Associated with Livestock, Recreation, and Residences on Multiple-Use Landscapes

WQ Study Summer of 2016

Objectives

- 1) quantify fecal indicator bacteria concentrations
- 2) compare to water quality standards
- 3) relationships between WQ, environmental conditions, and land use



WQ Summary

- Water quality on extensively grazed rangelands and forests is often high.
- 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.