Research Update: Grazing and Environmental Topics

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UC Davis and UC Cooperative Extension

UCCE Mendocino & Lake Counties
Ukiah, CA ● 21 October 2014

UCDAVIS UNIVERSITY OF CALIFORNIA | University of California Agriculture and Natural Resources

Updates – Grazing and….

- **Water quality**
- **Sensitive species conservation**
- **Riparian health**
- ***Timber harvest* and water quality**



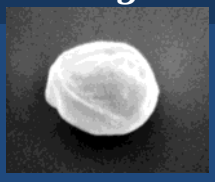
Rangeland Watershed Laboratory
http://rangelandwatersheds.ucdavis.edu

In the 1990's, concerns about…

- Microbial pollutants – *Cryptosporidium, E. coli*
- Sediment – erosion
- Stream Temperature – stream shade, tail-water
- Nutrients – nitrogen and phosphorus

Bay Area in 1995 - *Cryptosporidium*

Livestock ***Pathogen*** ***Drinking Water***



Cryptosporidium

Contra Costa Ti

Tiny parasite has water districts, cattle ranch

Parasite

Scientists seek watery solution to halt 'mystery spore' outbreak

Parasite risks

San Francisco water district targets cattle

Water district backs away from cattle grazing ban around lake

LOCAL

- Coho salmon was ESA listed
- Sediment and stream temperature
- 1997 TMDL consent decree for 22 northern California coastal watersheds

Ranch Water Quality Planning Short Course

- Partnership between UC, livestock industry, NRCD-RCDs, water boards, …
- 1995-2013, >80 courses taught, 1200+ ranches, 6+ million acres
- Ranch Water Quality Plan – tailored to ranch, watershed, regulatory vehicle

Survey – 10 north coast ranches

1. Determine primary on-ranch sediment sources and causes.
2. Current Management v. Background or Historic Management

49 sites "current"
- 0.2M yd^3 sediment
- 77% roads
- 1% livestock

56 sites "background"
- 41.0M yd^3 sediment

To protect water quality, many ranchers on California's North Coast are required to evaluate and mitigate the potential for delivery of sediment to streams on their property. Sheep graze on an oak woodland slope in the Russian River watershed.

Survey identifies sediment sources in North Coast rangelands

David J. Lewis ❑ Kenneth W. Tate ❑ John M. Harper ❑ Julie Price

We conducted a sediment source survey to gain insight into soil erosion on Northern California rangeland watersheds and to provide information to facilitate informed land-use management, conservation prioritization and water-quality regulation decisions. The results indicate that by focusing on erosion associated with natural and historical influences, inventory and assessment efforts on these watersheds can characterize the majority of sediment deliverable to streams. While this volume of sediment does not require mitigation under current water-quality regulations, it nonetheless prohibits the ability of in-stream sediment monitoring to detect water-quality changes. Water-quality regulations require managers to create inventories for all sources with 10 cubic yards or more of potentially deliverable sediment. If a monitoring threshold of 100 cubic yards was used, more than 99% of the deliverable sediment identified in this survey would be inventoried. This would require developing inventories for only 82 of the 117 sites in this study. Overall, we determined that rangeland managers can achieve the greatest reductions in sediment generation by focusing on erosion from roads.

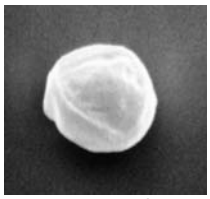
Total maximum daily loads (TMDLs) for sediment are being established for Northern California watersheds. These water-quality standards will require agricultural landowners to inventory, monitor and control management-caused erosion on their properties (EPA 1998; SWRCB 2001).

Twenty-four Northern California rivers are on the federal Clean Water Act (CWA) Section 303(d) list of impaired water bodies because of excessive sediment from erosion, which results in impacts for salmon habitat. Land-use management, including silviculture, development and agriculture, has been identified as a source of sediment in these watersheds

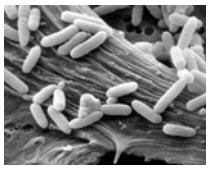
32 CALIFORNIA AGRICULTURE, VOLUME 55, NUMBER 4

19 years of microbial WQ study

?



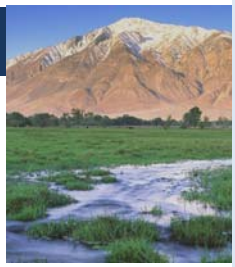
Cryptosporidium

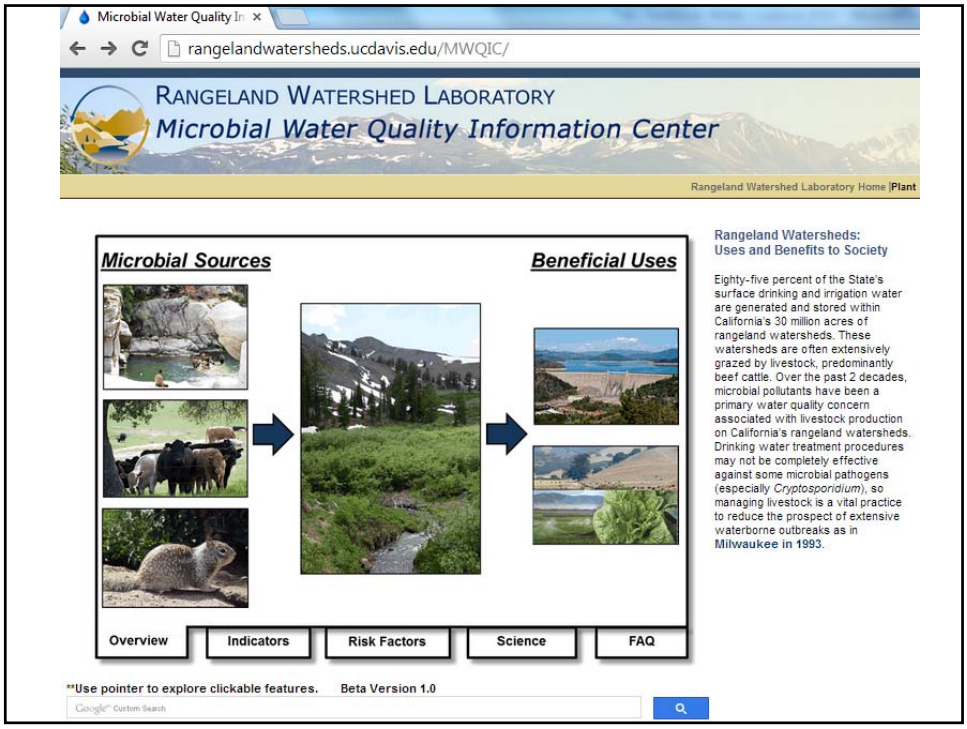


E. Coli O157:H7

Salmonella

?




Microbial Water Quality In
rangelandwatersheds.ucdavis.edu/MWQIC/
RANGELAND WATERSHED LABORATORY
Microbial Water Quality Information Center
Rangeland Watershed Laboratory Home |Plant
Microbial Sources
Beneficial Uses
Overview
Indicators
Risk Factors
Science
FAQ
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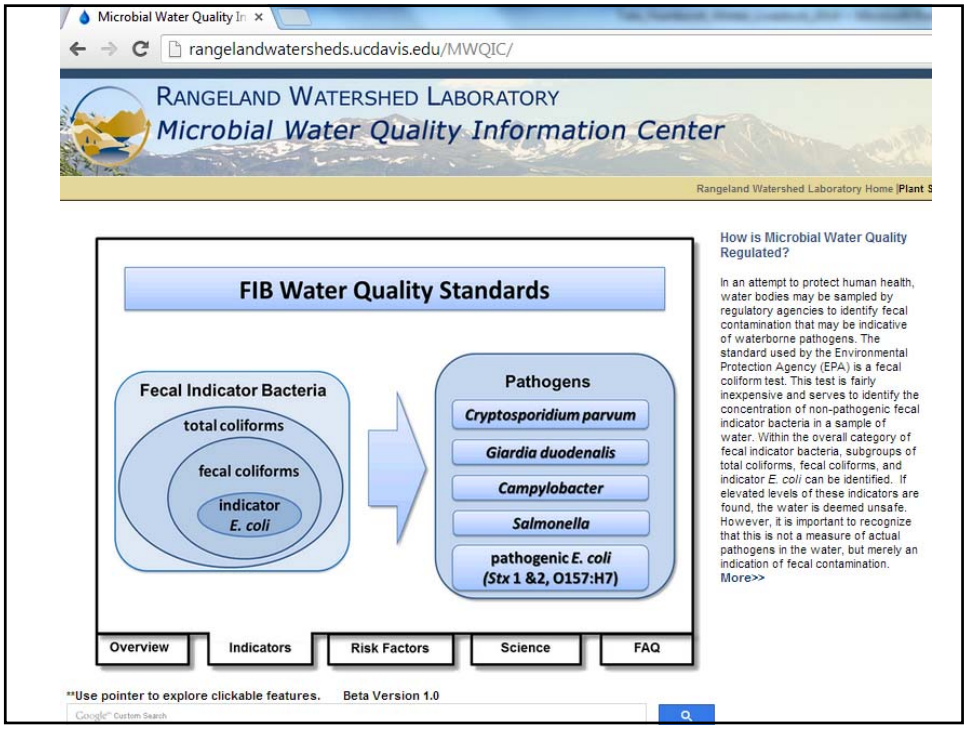
Beta Version 1.0
Rangeland Watersheds: Uses and Benefits to Society
Eighty-five percent of the State's surface drinking and irrigation water are generated and stored within California's 30 million acres of rangeland watersheds. These watersheds are often extensively grazed by livestock, predominantly beef cattle. Over the past 2 decades, microbial pollutants have been a primary water quality concern associated with livestock production on California's rangeland watersheds. Drinking water treatment procedures may not be completely effective against some microbial pathogens (especially Cryptosporidium), so managing livestock is a vital practice to reduce the prospect of extensive waterborne outbreaks as in Milwaukee in 1993.


Microbial Water Quality In
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Microbial Water Quality Information Center
Rangeland Watershed Laboratory Home |Plant
FIB Water Quality Standards
Fecal Indicator Bacteria
total coliforms
fecal coliforms
indicator E. coli
Pathogens
Cryptosporidium parvum
Giardia duodenalis
Campylobacter
Salmonella
pathogenic E. coli (Stx 1 &2, O157:H7)
Overview
Indicators
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Science
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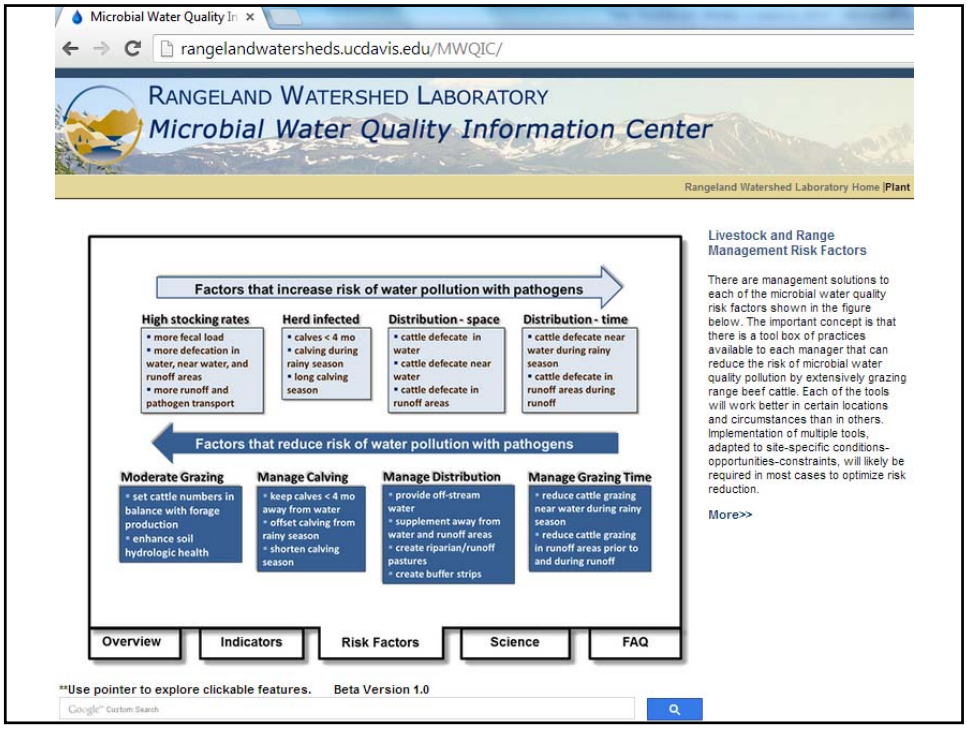
How is Microbial Water Quality Regulated?
In an attempt to protect human health, water bodies may be sampled by regulatory agencies to identify fecal contamination that may be indicative of waterborne pathogens. The standard used by the Environmental Protection Agency (EPA) is a fecal coliform test. This test is fairly inexpensive and serves to identify the concentration of non-pathogenic fecal indicator bacteria in a sample of water. Within the overall category of fecal indicator bacteria, subgroups of total coliforms, fecal coliforms, and indicator E. coli can be identified. If elevated levels of these indicators are found, the water is deemed unsafe. However, it is important to recognize that this is not a measure of actual pathogens in the water, but merely an indication of fecal contamination.
More>>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Factors that increase risk of water pollution with pathogens
High stocking rates
• more fecal load
• more defecation in water, near water, and runoff areas
• more runoff and pathogen transport
Herd infected
• calves < 4 mo
• calving during rainy season
• long calving season
Distribution - space
• cattle defecate in water
• cattle defecate near water
• cattle defecate in runoff areas
Distribution - time
• cattle defecate near water during rainy season
• cattle defecate in runoff areas during runoff
Factors that reduce risk of water pollution with pathogens
Moderate Grazing
• set cattle numbers in balance with forage production
• enhance soil hydrologic health
Manage Calving
• keep calves < 4 mo away from water
• offset calving from rainy season
• shorten calving season
Manage Distribution
• provide off-stream water
• supplement away from water and runoff areas
• create riparian/runoff pastures
• create buffer strips
Manage Grazing Time
• reduce cattle grazing near water during rainy season
• reduce cattle grazing in runoff areas prior to and during runoff
Overview
Indicators
Risk Factors
Science
FAQ
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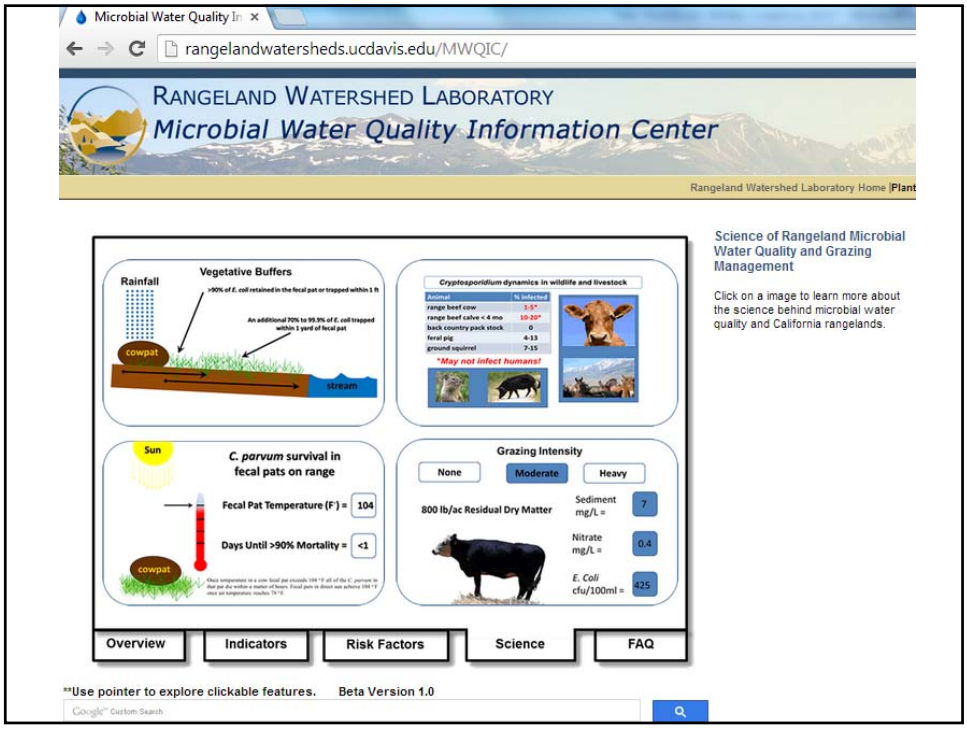
Livestock and Range Management Risk Factors
There are management solutions to each of the microbial water quality risk factors shown in the figure below. The important concept is that there is a tool box of practices available to each manager that can reduce the risk of microbial water quality pollution by extensively grazing range beef cattle. Each of the tools will work better in certain locations and circumstances than in others. Implementation of multiple tools, adapted to site-specific conditions-opportunities-constraints, will likely be required in most cases to optimize risk reduction.
More>>


Microbial Water Quality In
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Microbial Water Quality Information Center
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Rainfall
Vegetative Buffers
cowpat
stream
Cryptosporidium dynamics in wildlife and livestock
Animal
% Infected
range beef cow
1-5*
range beef calve < 4 mo
10-20*
back country pack stock
0
feral pig
4-13
ground squirrel
7-15
*May not infect humans!
Sun
C. parvum survival in fecal pats on range
Fecal Pat Temperature (F) = 104
Days Until >90% Mortality = <1
cowpat
Grazing Intensity
None
Moderate
Heavy
800 lb/ac Residual Dry Matter
Sediment mg/L = 7
Nitrate mg/L = 0.4
E. Coli cfu/100ml = 425
Overview
Indicators
Risk Factors
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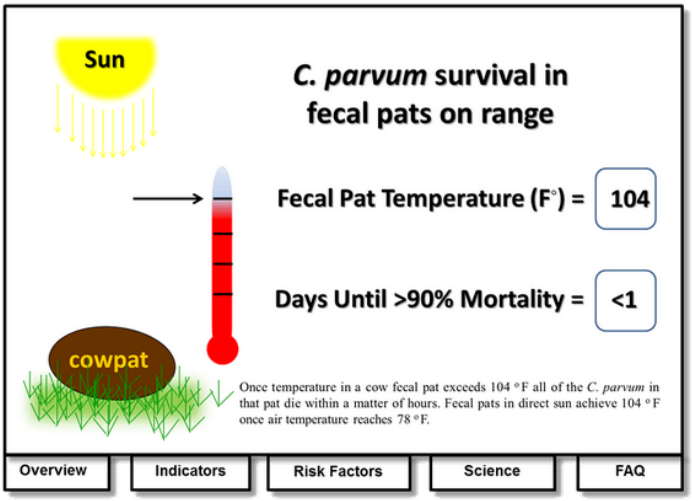
Science of Rangeland Microbial Water Quality and Grazing Management
Click on a image to learn more about the science behind microbial water quality and California rangelands.

Key Findings

Cryptosporidium eggs die in one day of 78 F air temperature in direct sun.

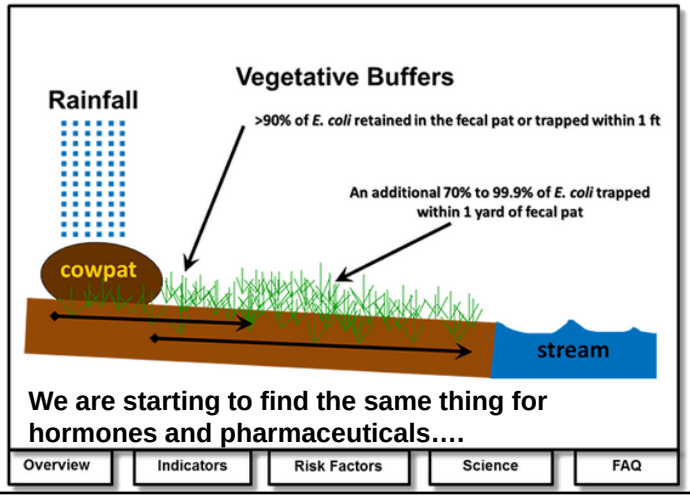


Cryptosporidium parvum Survival in the Environment

The survival of pathogens in the environment is highly correlated to weather patterns. In hot weather, feces quickly dry out, killing most pathogens that were contained within them. In cooler weather, fecal pats are a more favorable environment for pathogens as the pats remain moist for a much longer period of time. To evaluate and confirm this phenomenon, we measured the ambient temperature and the temperature within fecal pats in two different environments- sun and shade, for a year. More>>

Key Findings

E. Coli are trapped in fecal pat or soil within 1 yard down slope during runoff.

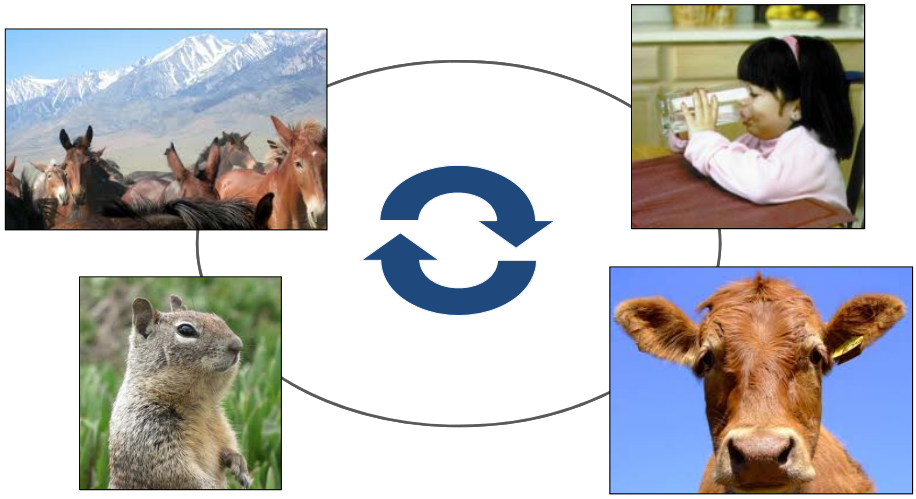


Vegetative Buffer

Non-point source pollution as a result of overland flow during rainfall events is a common transport mechanism for pathogens. Pathogens in fecal material can certainly be directly deposited in a water body by an animal, but livestock and wildlife spend more hours grazing and resting on the surrounding watershed than they do drinking or cooling in a creek or stream. The proximity of contaminated fecal material is a key factor in determining whether or not the pathogen will be able to reach water- Our research has demonstrated that, for indicator *E.coli*, more than 90% of the bacteria was retained within a fecal pat or trapped within 1 foot downslope. More>>

The Key New Finding

Most Cryptosporidium in cattle does not appear to be the type infectious to humans.



The Key New Finding

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

Crytposporidium	No. Observations
C. ryanae	61/81 (75%)
C. bovis	19/81 (24%)
C. andersoni	1/81 (1%)
C. parvum	**0/81 (0%)**

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

K. Flores *et al.*

Sac Bee, April 2010

USFS Grazing Allotments

"Livestock waste found to foul Sierra waters"

"…incredible weapon of mass destruction"

"No livestock above 5000 feet"

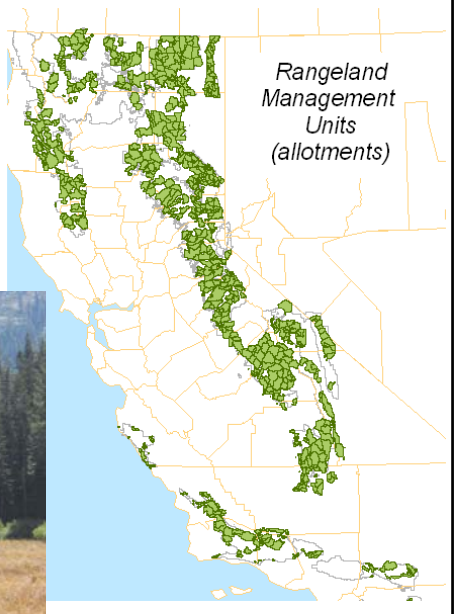
USFS Public Grazing Allotments in CA

500 grazed allotments

8,000,000 acres

430,000 Animal Unit Months

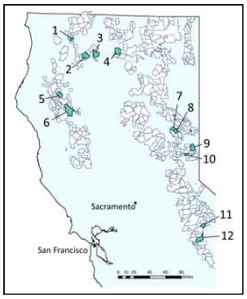
~70,000 head of cattle



Public Lands Grazing & Water Quality

Comprehensive Water Quality Survey

- 12 USFS public lands grazing allotments, 5 National Forests.
  - 320,000 acres
- 155 stream collection sites, monitored monthly during grazing-recreation period (Jun-Nov, 2011).
  - Key Grazing Areas
  - Recreation Areas
  - Areas with No Concentrated Use Activities
- Total of 743 water samples collected
  - Fecal Indicator Bacteria: Fecal coliform, *E. coli*
  - TN, NO_3-N, NH_4-N, TP, PO_4-P



Public Lands Grazing & Water Quality

Results

- Observed nutrient concentrations were at least one order of magnitude below levels of ecological concern, and similar to background estimates.
- All but the most restrictive fecal indicator bacteria (FIB) water quality benchmarks were broadly met.
- Throughout the study period, US EPA recommended *E. coli* benchmarks were met for over 90% of samples collected and over 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."

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.

Water Quality Standards

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**
E. coli > 190 cfu/100ml	5	4	4	6
E. coli > 235 cfu/100ml	3	3	3	4
NO_3-N > 300 µg/L	0	0	0	0
TP > 100 µg/L	2	2	2	<1
PO_4-P > 50 µg/L	<1	1	0	0

WQ Summary

- Water quality on extensively grazed rangelands and forests is high.
- Management can create risk to 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.

Grazing Management & Conservation of Threatened or Endangered Species

- Yosemite Toad - Proposed for ESA listing
  - Believed to be declining
  - Mountain Meadows = key toad breeding and rearing habitat
  - Mountain Meadows = key forage for livestock
  - Livestock a potential driver of decline?

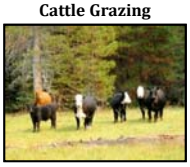
- 2005-2010 Yosemite Toad Study
  - *USFS, UC Davis, UC Berkeley, and range stakeholders*.

Public Lands Grazing & Yosemite Toad

CATTLE EXCLUSION EXPERIMENTS

- 3 meadow breeding pool fencing treatments
  - Fence entire meadow
  - Fence breeding pools only
  - Not fenced

Cattle Grazing



Yosemite Toad

RESULTS

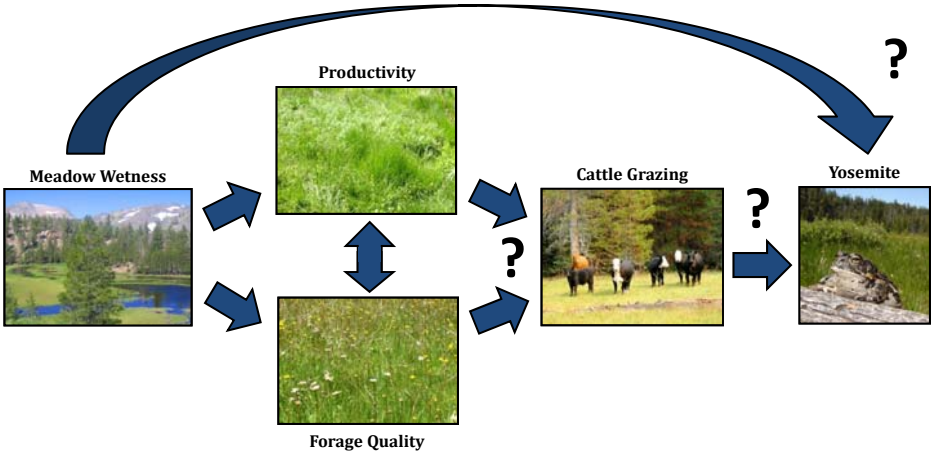
- Observed nutrient concentrations 1 order of magnitude below levels of ecological concern.
- Water quality and hiding cover not different among grazed and ungrazed treatments.
- No increase in toad occupancy, tadpole-young of the year density due to fencing.
- No difference between fenced and not fenced pools.

Roche *et al.* 2012. *Rangeland Ecology & Management.* McIlroy *et al.* 2013. *PLOS ONE.*

Public Lands Grazing & Yosemite Toad

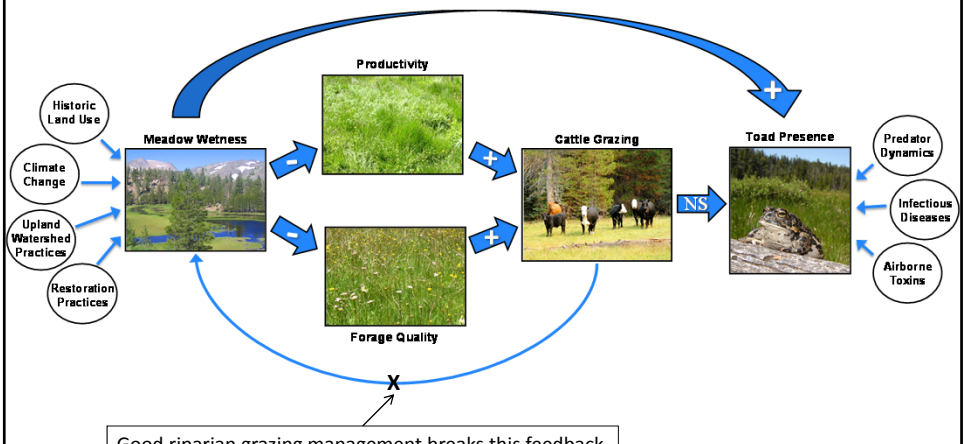
Survey of Cow and Toad Habitat Use/Competition

- 3 Sierra National Forest Grazing Allotments
- 24 Meadows ranging from wet to moist, all open to grazing cattle



Public Lands Grazing & Yosemite Toad

There is something at work here bigger than grazing



Cattle grazing and conservation of amphibians appear to be compatible goals

Cattle Grazing and Yosemite Toad (*Bufo canorus* Camp) Breeding Habitat in Sierra Nevada Meadows
L.M. Roche, B. Allen-Diaz, D.J. Eastburn, and K.W. Tate. 2012. Rangeland Ecology & Management 65:56-65.

Cattle grazing and conservation of a meadow-dependent amphibian species in the Sierra Nevada
L.M. Roche, A.M. Latimer, D.J. Eastburn, and K.W. Tate. 2012. PLOS ONE.

Determining the effects of cattle grazing treatments on Yosemite toads (*Anaxyrus canorus*) in montane meadows.
S. McIlroy, A.J. Lind, B.H. Allen-Diaz, L.M. Roche, W.E. Frost, R.L. Grasso, and K.W. Tate. 2013. PLOS ONE.

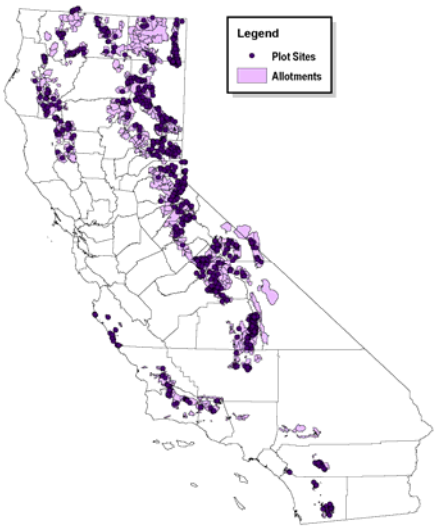
Grazing and Meadow Health

USFS Region 5 Meadow Condition and Trend Monitoring

- Sierra Nevada Forest Plan Amendment (early 2000s) – Set Riparian grazing utilization limits (i.e. browse on willow, bank trampling, amount of annual forage consumed).
- 1998: USFS initiated long-term meadow condition and trend monitoring program.
  - **1)** Document baseline meadow conditions as new riparian use limits were coming into use.
  - **2)** Examine long-term trends in meadow condition following implementation of limits.
- UC Davis Rangeland Watershed Lab partnering with USFS to analyze these data.

Meadow Condition Monitoring 1999-2013

- **850 Permanent plots**
  - Read every 5 years
  - Over 270 with 10 years of data
- **Plant species composition**
  - Diversity
  - Richness
  - Soil Stabilization Score
- **Current data analysis**
  - Meadow Condition
  - Trends in Condition
  - Weather x Site Type x Management



Comparing Grazing w/ Riparian Use Limits to Non-Grazed Conditions

Inyo National Forest

Four Allotments

2000-2010

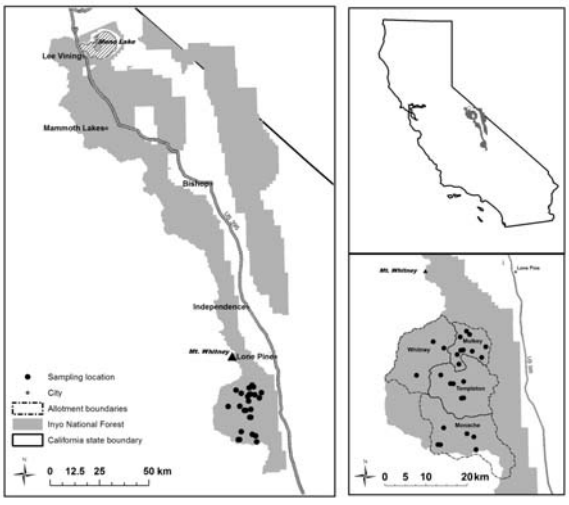
2 closed to grazing

2 grazed with riparian use limits

25 monitoring plots

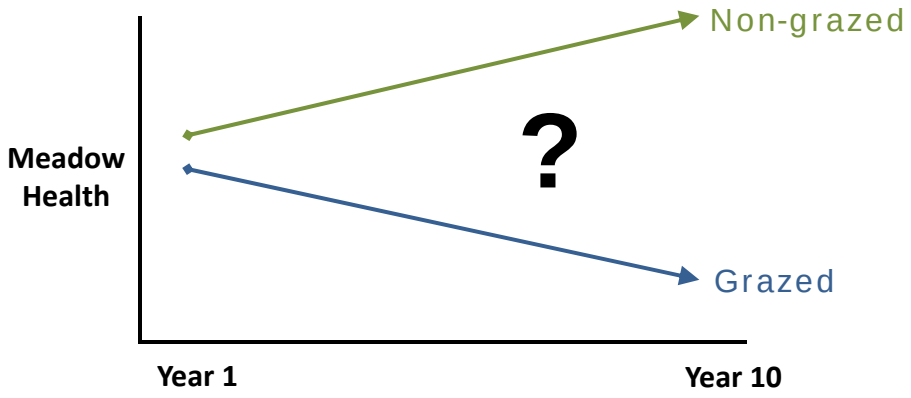
16 grazed

9 non-grazed



Comparing Grazing w/ Riparian Use Limits to Non-Grazed Conditions

Tested the hypothesis that meadow conditions would improve more in the non-grazed compared to grazed allotments.



Results

- Livestock exclusion did not lead to greater rates of meadow recovery compared to grazing to achieve riparian use limits.
- Grazing management implemented to achieve riparian use limits did not degrade meadow health.
- Demonstrates the effectiveness of 1. setting riparian utilization objectives, and 2. grazing management practices (i.e., herding, rest, rotation).

Some recent relevant reviews

Rangeland Literature Synthesis

Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps

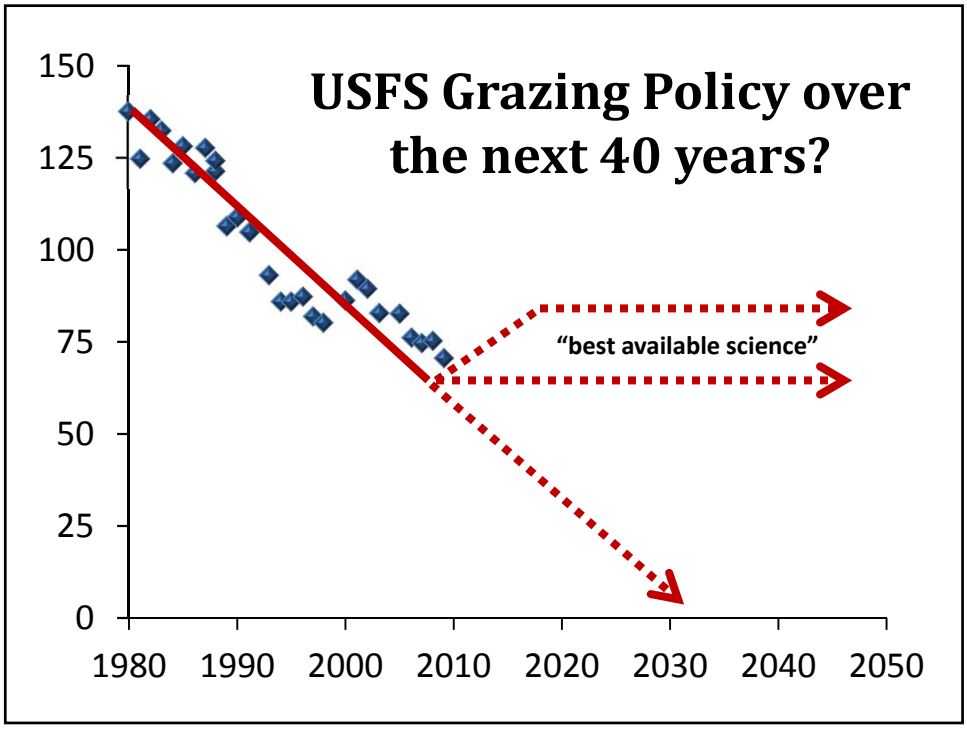
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1045811

Western Land Managers will Need all Available Tools for Adapting to Climate Change, Including Grazing: A Critique of Beschta et al.

Environmental Management

Tony Svejcar • Chad Boyd • Kirk Davies • Matthew Madsen • Jon Bates • Roger Sheley • Clayton Marlow • David Bohnert • Mike Borman • Ricardo Mata-Gonza`lez • John Buckhouse • Tamzen Stringham • Barry Perryman • Sherman Swanson • Kenneth Tate • Mel George • George Ruyle • Bruce Roundy • Chris Call • Kevin Jensen • Karen Launchbaugh • Amanda Gearhart • Lance Vermeire • John Tanaka • Justin Derner • Gary Frasier • Kris Havstad

http://rangelandwatersheds.ucdavis.edu/main/GrazingPublicLandsClimateChange/index.html



Aquatic Ecosystem Response to Timber Harvesting for the Purpose of Restoring Aspen

Jones, B.E, M. Krupa, and K.W. Tate. 2013. PLOS ONE.

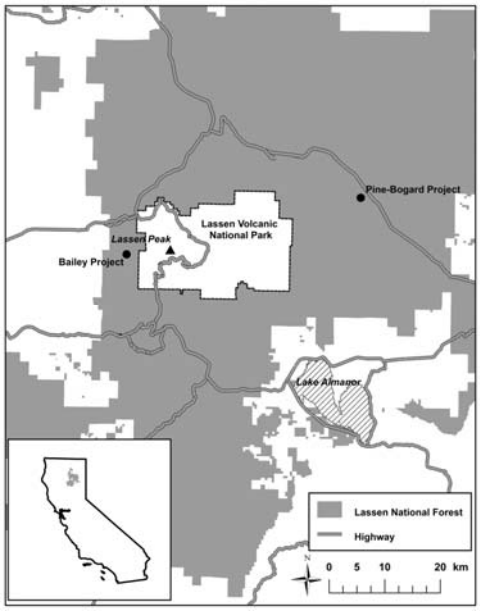
An 8 year study of stream response to use of commercial timber harvest as a tool to liberate riparian aspens encroached by conifers.

- Many riparian aspen stands encroached by conifers
- Conifer removal is an effective release strategy

Some Concerns

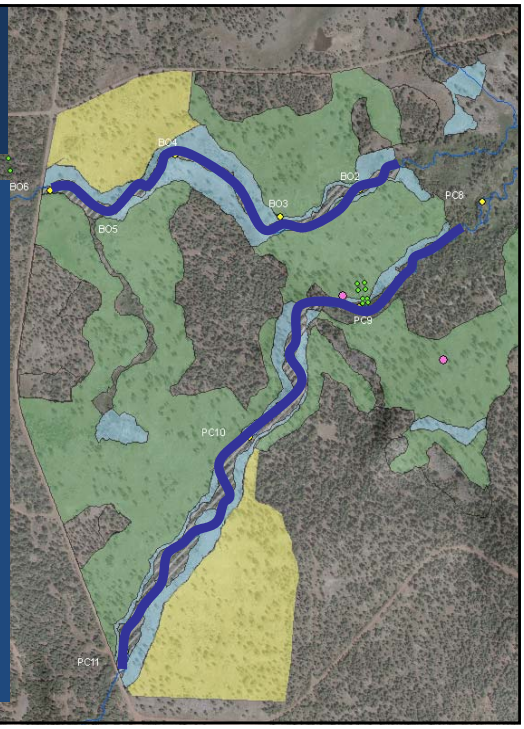
- Reduce stream canopy cover?
- Increase stream temperature?
- Degrade water quality and aquatic habitat?
- Compact soils?

Study Sites



Lassen NF Pine-Bogard Creek

- 260 acres treated
- 5,910 feet on Pine Creek
- 3,590 feet on Bogard Creek
- Over snow and late summer treatments
- 15 to 125 feet from stream



Aquatic Ecosystem Response to Timber Harvesting for the Purpose of Restoring Aspen

Results

- Over 1000 water samples collected, >80% below detection limits for nitrogen and phosphorus, none above levels of ecological concern.
- No increase in sediment, nutrients, temperature during or following timber removal.
- Stream macroinvertebrate communities indicative of high quality habitat throughout study period.
- With careful planning and implementation, conifer removal (harvest) can be conducted without degrading aquatic ecosystems.

What is all this research telling us?

- With good management – livestock & timber production, clean water, healthy riparian areas, and conservation of sensitive species are compatible goals. It takes work and goal setting.
- Substantial new science supports this conclusion.
- Make certain this science is integrated into policy and management decision making – best available science.
- Collaboration and communication between managers, policy makers, and scientists is essential.

Rangeland Watershed Laboratory
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