Water quality and rangeland management: a review of the scientific literature.

Lewis Reed

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- Watershed Function and Rangelands in Watersheds
- Livestock as part of the Ecosystem
- Water Quality: Parameters and Livestock Interactions
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What did I do?

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Cryptosporidium parvum transport from cattle fecal deposits on California rangelands

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Abstract

Cryptosporidium parvum **is a fecal borne protozoan parasite that can be carried by and cause gastrointestinal illness in humans, cattle, and wildlife. The illness, cryptosporidiosis, can be fatal to persons with compromised immune systems. At question is the potential for *C. parvum* in cattle fecal deposits on rangeland watersheds to contaminate surface water. First, *C. parvum* oocysts must be released from fecal deposits during rainfall, becoming available for transport. In 1996, we examined the transport of *C. parvum* oocysts in overland flow from fecal deposits under natural rainfall and rangeland conditions at the San Joaquin Experimental Range in Madera County, Calif. Our null hypothesis was that *C. parvum* oocysts are not released from fecal pats and transported 1 m downslope as overland flow with rainfall. Paired plots were located on 10, 20, and 30% slope sites. Each plot was loaded with four, 200 g fecal pats dosed with 10^5 oocysts g^{-1}. Pats were placed 1.0 m above the base of each plot. Composite runoff samples from each plot were analyzed for oocyst concentration following each of 4 storm events. Oocysts were transported during each storm. Slope was a significant factor in oocyst transport, with oocyst transport increasing with slope. Although not significant, there was an apparent flushing effect of oocysts across storms, with the majority transported in the first 2 storms. A pilot rainfall simulation experiment also revealed a flushing phenomenon from pats during individual rainfall events. *C. parvum* oocysts in fecal pats on rangeland can be transported from fecal deposits during rainfall events, becoming available for transport to water-bodies. Future studies need to examine surface and subsurface transport of oocysts on rangeland hillslopes for distances greater than 1 m.**

Key Words: pathogens, water quality, fate and transport, buffer strip

Cryptosporidium parvum (Tyzzer 1912), a fecal-oral protozoan parasite, is an important etiologic agent of enterocolitis in mammals. *C. parvum* appears to be infectious for and is shed by humans, domestic animals, and wildlife species (Casemore et al. 1997). Waterborne transmission to humans has emerged as a leading public health problem here and abroad (MacKenzie et al. 1994, LeChevallier and Norton 1995). Public health officials have considered cattle as possible sources of this parasite because of *C. parvum* infection within cattle populations (MacKenzie et al. 1994). In 1997, the City of San Francisco, Calif. proposed to terminate long-standing grazing leases and ban cattle from 12,000

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Resumen

Cryptosporidium parvum **es un protozoario parásito que se transporta en las heces fecales y que puede ser acarreado por humanos, bovinos y fauna silvestre a los que puede causar enfermedades gastrointestinales. La enfermedad cryptosporidiosis puede ser fatal para personas con un sistema inmunológico débil. Se cuestiona el potencial del *C. parvum* contenido en las heces fecales de bovinos depositadas en las cuencas hidrológicas de pastizal para contaminar las aguas superficiales. Primero, los oocistos del *C. parvum* deben ser liberados de las heces fecales durante la ocurrencia de lluvias para estar disponibles para ser transportados. En 1996, en la Estación Experimental de Pastizales de San Joaquín en el condado de Madera, Calif., examinamos el transporte de oocistos de *C. parvum* en el flujo superficial proveniente de áreas con depósitos fecales bajo lluvia natural y en condiciones de pastizal. Nuestra hipótesis nula fue que los oocistos de *C. parvum* no son liberados de los depósitos fecales y transportados 1 m cuesta abajo como en el flujo superficial de la lluvia. Se localizaron parcelas apareadas en sitios con 10, 20 y 30% de pendiente. En cada parcela se colocaron 4 depósitos fecales de 200 g de dosificados con 10^5 oocistos g^{-1}, las heces fecales se colocaron 1 m arriba de la base de cada parcela. Se analizaron muestras compuestas del escurrimiento de cada parcela para determinar la concentración de oocistos después de cada uno de 4 eventos de lluvia. Los oocistos fueron transportados durante cada tormenta. La pendiente fue un factor significante en el transporte de oocistos, incrementandose el transporte al aumentar la pendiente. Aunque no significante, hubo un efecto aparente de lavado de los oocistos a través de las tormentas, en donde la mayoría de ellos se transportaron en las primeras 2 tormentas. Un experimento piloto con simulador de lluvia también revelo este fenómeno de lavado durante eventos individuales de lluvia. Los oocistos de *C. parvum* de heces fecales localizadas en pastizales pueden ser transportadas durante los eventos de lluvia, llegando a ser disponibles para su transporte a cuerpos de agua. Se necesitan estudios futuros para examinar el transporte superficial y subterráneo de oocistos en las montañas de pastizal a distancias mayores de 1 m.**

Watershed Function

- We rely on functioning watersheds to capture, cleanse, and yield clean water
- Activities in watersheds effect local and regional water quality
- One challenge is that lands within a watershed are managed by a variety of stakeholders with a variety of goals

Rangelands

- In central coastal CA, much of our watersheds are used as range
- Private ranches
- Public lands managed with livestock
- Rangeland managers are water resource stewards!

Ecosystem Functions of Livestock

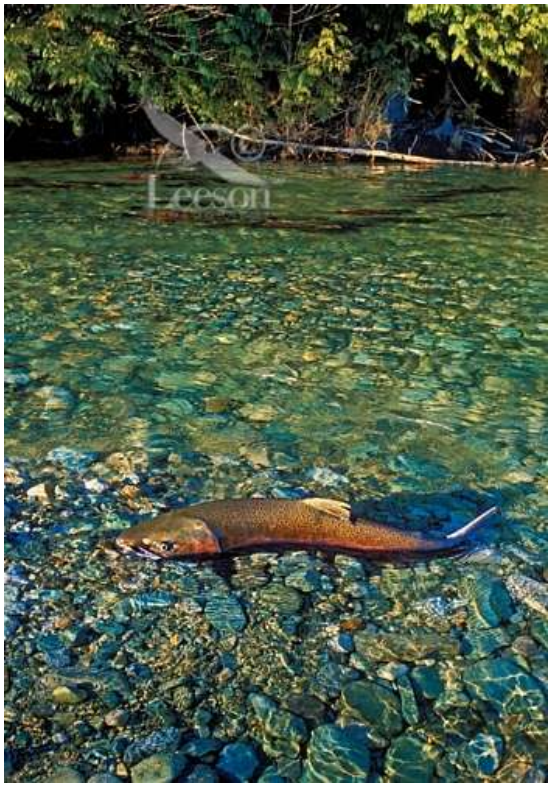
- Livestock have a niche
- Important primary consumers
- Redistribution of nutrients
- Effects on vegetation and plant growth form

Water Quality

- Physical Properties
  - Sediment
- Chemical Properties
  - Nitrogen
  - Phosphorus
- Biotic Properties
  - Pathogens
  - Algae

Physical: Sediment Transport

- Filling of stream channels and ponds
- Conversion of substrate textures (spawning fish)



Physical: Sediment Transport

A.

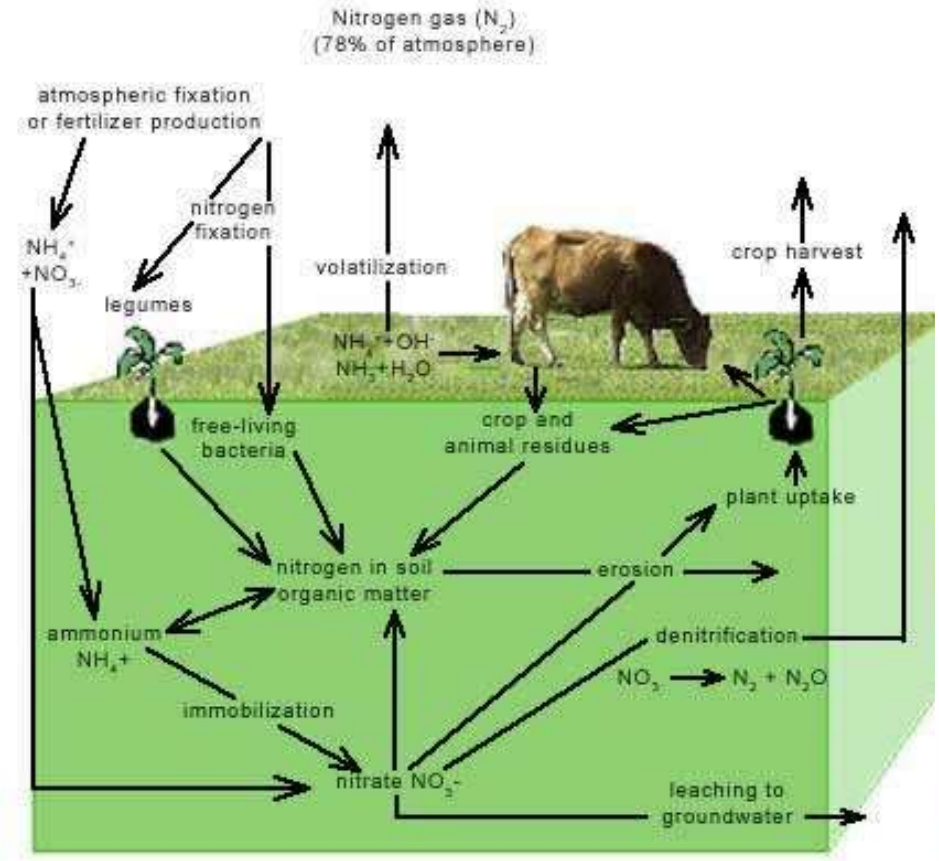
B.

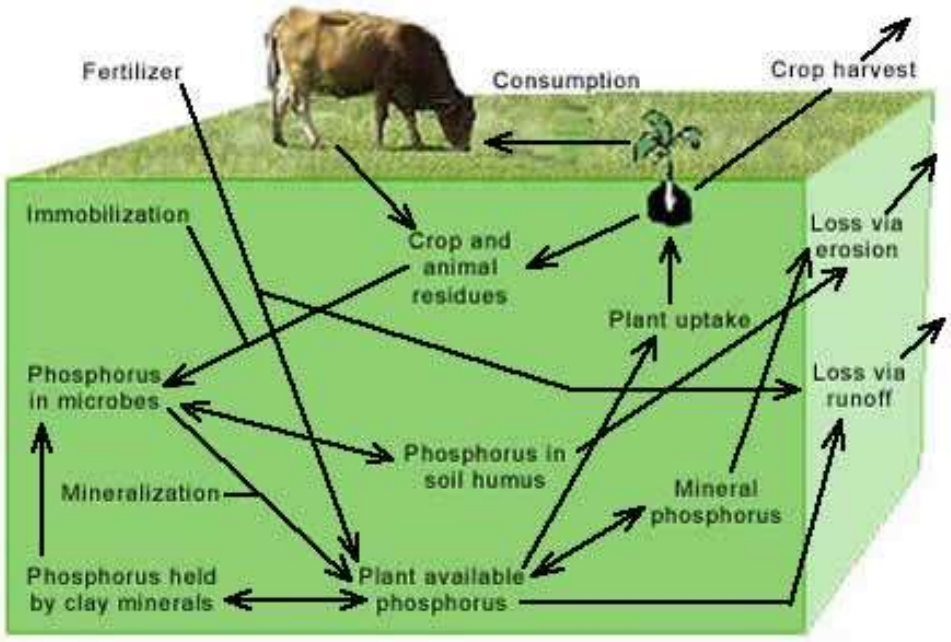
Chemical: Nutrient Dynamics

- Focus on Nitrogen and Phosphorus

- Pulses of highly labile limiting nutrients may cause eutrophication.

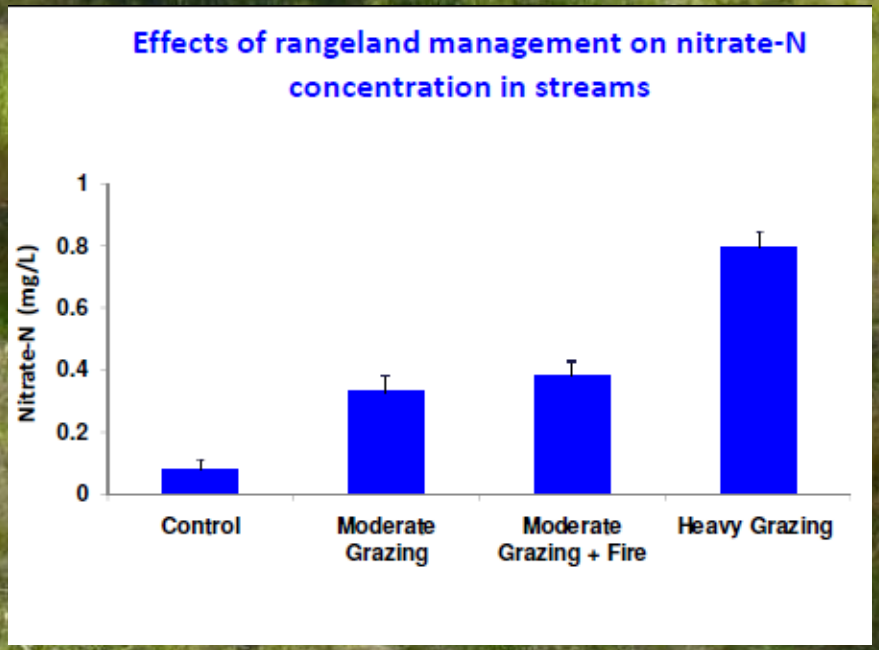
Chemical: Nutrient Dynamics





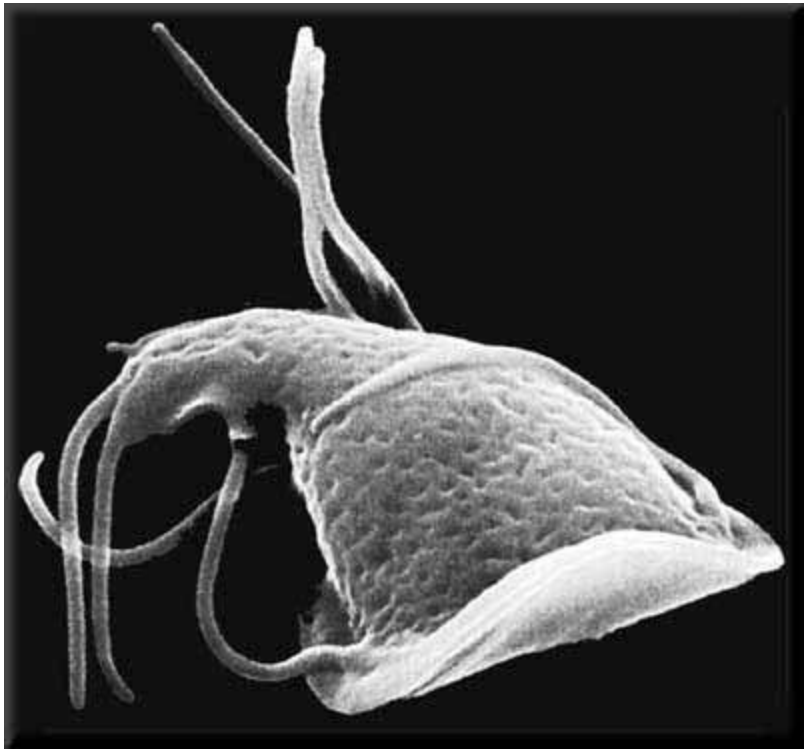
Chemical: Livestock Interactions

- **Livestock Interactions**
  - **Deposition of soluble nutrients in cattle wastes can contribute to eutrophication and N contamination**
  - **Moderate grazing of wet grasslands can decrease dissolved N concentrations**



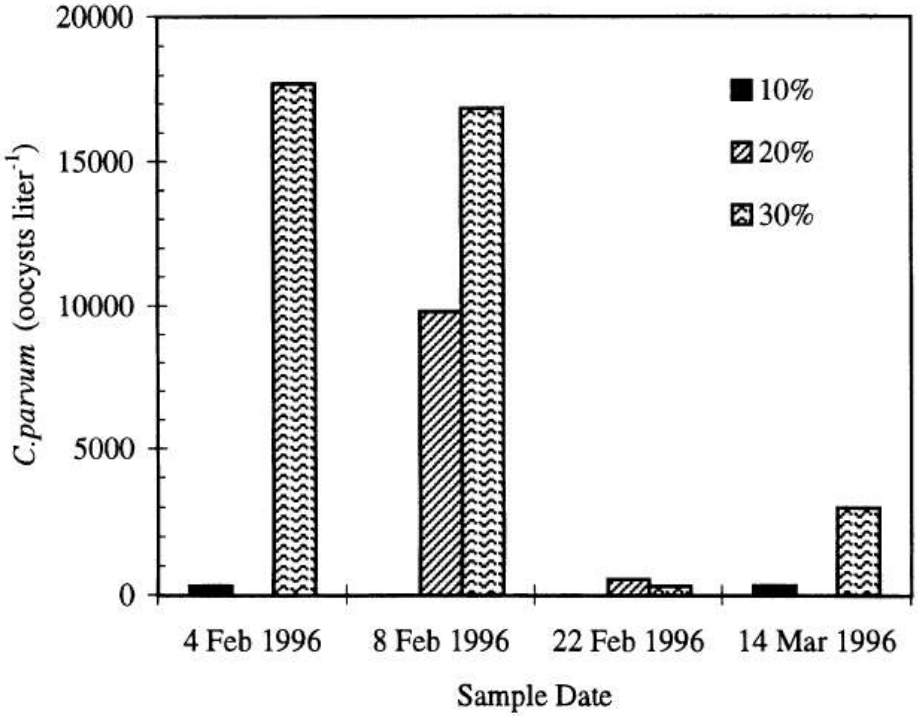
Biotic: Pathogens and Algae

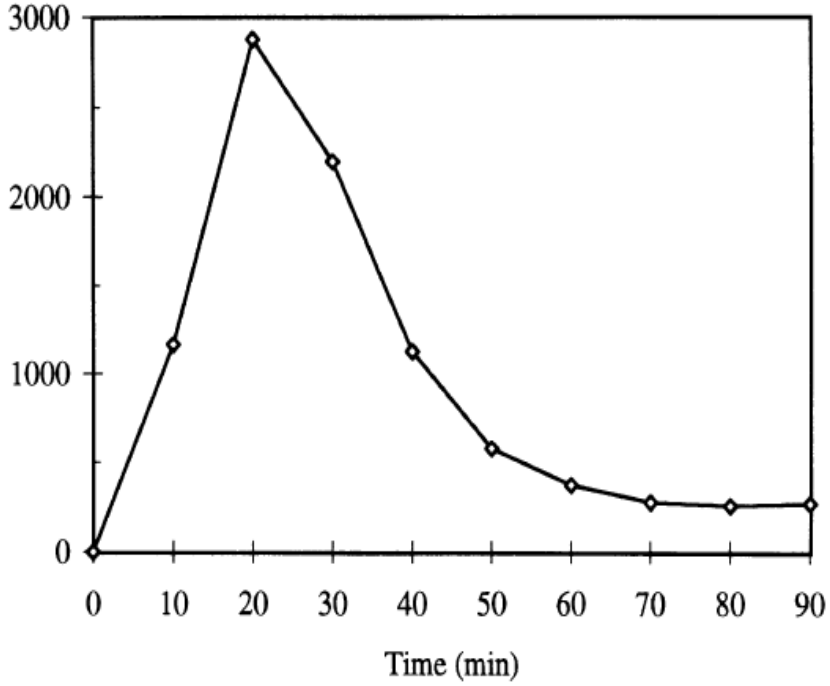
- Pathogens
- Algae (toxic vs. eutrophication)



Biotic: Livestock Interactions

- Fecal contact with water sources
- Nutrient inputs to water sources


20000
15000
10000
5000
0
C.parvum (oocysts liter-1)
10%
20%
30%
4 Feb 1996
8 Feb 1996
22 Feb 1996
14 Mar 1996
Sample Date


3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
Time (min)

Livestock Management for Water Quality

- Tools to influence when and where the animals are on in the landscape.
  - Fencing
  - Prescribed seasonal grazing
  - Behavioral modification
    - Herding
    - Training
  - Attractants
    - Feeding stations
    - Watering Troughs
    - Mineral/Molasses

Other Considerations

- Animal concentration areas
  - Fence lines
  - Corrals
- Rangeland Infrastructure
  - Roads
  - Stream crossings

Strategies: Riparian Buffers and Pastures

Strategies: Alternate Water Sources

Strategies: Timing of Access

Conclusion

- Rangelands comprise a large portion of the watersheds we rely on for local and regional water supply.
- Livestock management may contribute to or mitigate affects of non point water contamination.
- Strategies for one goal may be at odds with others: adaptability and responsiveness are the key.

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