EFFECTS OF ROTATIONAL BEEF CATTLE GRAZING ON MICROBIAL PARAMETERS OF ELK RIVER, HUMBOLDT COUNTY CA

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Outline of Talk

Justin Harrison's M.S. Thesis

1. Hypotheses
2. Study Site
3. Methods
4. Results

Musings on Sources of Fecal Coliforms in Elk River

Impetus for Study

- We were invited by Andy Westfall to study water quality impacts of his well-managed livestock operation on Elk River.
- Management included riparian exclusion, fenced paddocks, plenty of vegetative cover throughout, limited grazing during wet season.
- Neighbors had expressed concerns about water quality with reintroduction of livestock to the Westfall/Mazzucchi Ranch.

Hypotheses, that there will be…

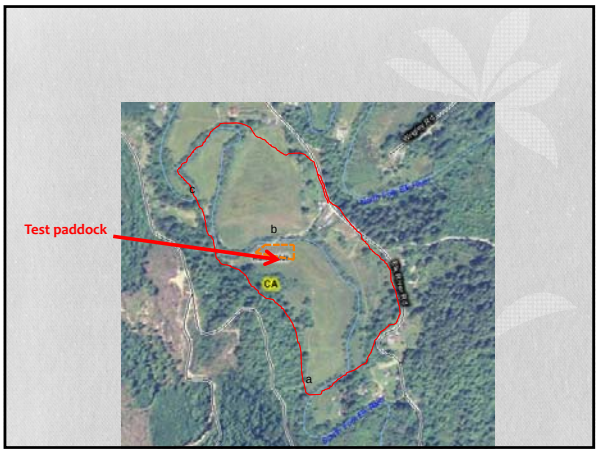
- no significant differences in fecal coliforms (FC) in water associated with grazing activities.
- no significant differences in FC and *Salmonella* in soil before and after cattle grazing.

Justin Harrison measured:

- FC concentrations in Elk River (concurrent with North Coast Regional Water Quality Board sampling)
- FC and *Salmonella* concentrations in soil and bovine fecal pats of one paddock.

Study Site – Westfall Mazzucchi Ranch

Stream Crossing – Sampling Site "b"

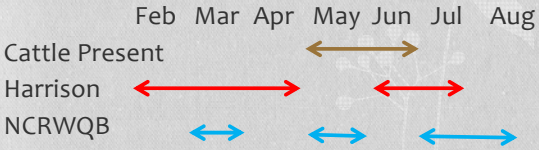


Paddock used for cow pat and soils experiment

Site History, Soil Type, and Management

- Dairy farm until 2002
  - Beef cattle returned May 2009
- Russ Series: coarse-loamy, mixed, superactive, nonacid, mesic Typic Udifluvents
  - Loam texture
  - Typically found on nearly level slopes under pasture
- Short duration, high intensity grazing with limited direct contact between livestock and surface water.

Methods – 2010 Sampling Schedule

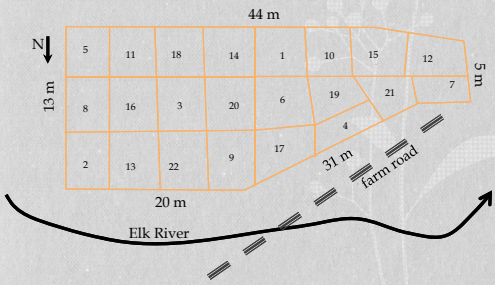


Methods for Water Samples (CFUs/100mL)

- Kick and grab for water samples, 3 samples composited into one sterile 500 mL bottle
- Membrane filtration & Incubation

Methods for Soils

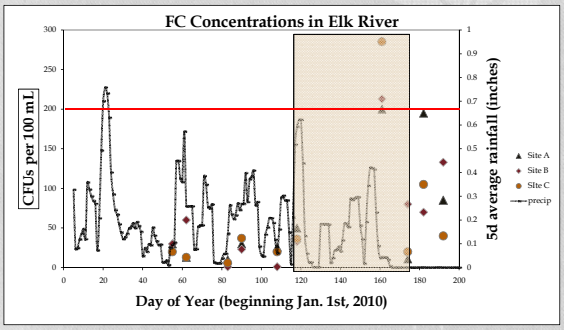
- Soils collected from top 5 cm, every 2 to 3 days (July 2010) in randomly assigned subplots within one paddock, also sampled three cow pats.



Soil/cow pat

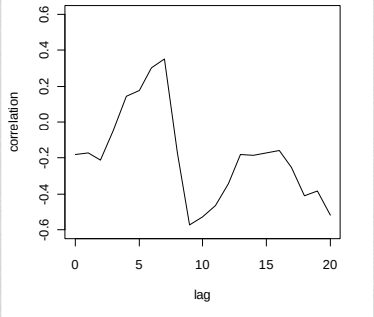
- Moisture content
  - consistent dry weight basis
- Diluted in a buffer solution
  - 0.1% Peptone and reverse osmosis water
- Membrane filtration
  - mFC agar for fecal coliform
  - SS agar for *Salmonella*, isolated in Tetrathionate (TT) broth

Results

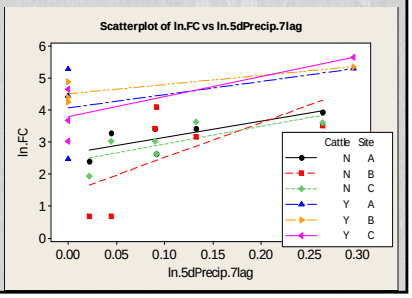


Does rainfall affect FC concentrations?

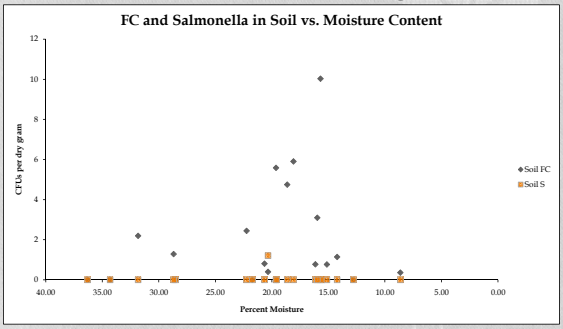
7 days after rainfall event showed highest correlation with Fecal Coliform (FC) concentrations in Elk River



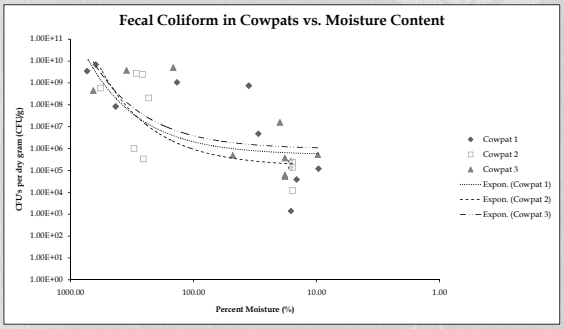
As rainfall increases, so does FC.
No difference between upstream (A), crossing (B) or downstream (C) (p=0.84).
Significant difference in FC values between presence and absence of cattle.



No clear relationship between FC and Salmonella in soils as a function of moisture, max. 10 CFUs/gram dry soil.



The older and drier the cow pats were, FC values decreased



Summary of Results

Over the course of several summer months – NOT during first flush, wet events…

- Fecal coliforms (FC) in Elk River upstream and downstream of the ranch property were indistinguishable.
- Soil FC were low and *Salmonella* were barely detectable.
- FC in cow pats declined to 10% viability within about one month (similar to results obtained by Atwill, Tate and others)

Predictions come true!

As our local ranchers told us at the beginning of the study –

NOT ALL BEEF CATTLE RANCHING IS THE SAME – MANAGEMENT COUNTS AND MUST BE TAKEN INTO ACCOUNT!

In this study there **is no evidence that cattle had any influence on FC** in Elk River during the time period studied…

Also, keep in mind that the Westfall Mazzucchi ranch makes up less than 1% of the land area in the watershed and is on nearly level floodplain terraces above Elk River.

Is Elk River Impaired by Bacterial Contamination?

Humboldt Bay and Watershed Fecal Coliform Study

February 2003, Prepared by: Jill K. Geist

Humboldt Bay Shellfish Technical Advisory Committee

"Fecal coliform concentrations at the **Elk River** locations remained consistent and exhibited constant sources of fecal coliform loading. This sub-basin warrants additional investigation."

"Elk River at 101 Bridge - T14a

Site T14a background level was 20 MPN. However, it appears that the wet season background level is higher, closer to 500 MPN. This site had consistently elevated coliform concentrations with very little change from Day 1 to Day X during the first three storm events. There appears to be a constant source of fecal coliform present during the wet season."

What other FC sources exist?

Upstream of Westfall Mazzuchi Ranch:

- 4 to 5 residences with septic systems, limited livestock, and pets
- Wildlife

Upstream of Elk River at Hwy 101:

- Many more residences on septic systems, livestock with varying degrees of direct access to surface water, pets
- Wildlife

Why do we care?

- We are looking for easy-to-measure indicators that alert us to the presence of disease-causing organisms.
- Scientific research continues and more questions are raised than answered in many cases.
- It is extremely difficult to determine sources of FC (Humans? Wildlife? Livestock? Free-living coliforms?)

Current and Future Approaches

MICROBIAL SOURCE TRACKING (MST) – four broad approaches:

- 1. Biochemical (phenologic) – antibiotic resistance profiles
- 2. Molecular (genotypic) – based DNA fingerprinting techniques
- 3. Chemical – optical brighteners, caffeine, etc. (human)
- 4. Immunological – unique proteins

Challenges with MST:

- Some methods require expensive libraries of genetic information.
- Wide genetic variation occurs within herds and other groupings, and also as a function of season, diet, antibiotics administered, etc.
- Environmental variables, such as light, temperature, turbidity, and predation on microorganisms can alter their decay rates.

The Penultimate Slide

Quote from Tomales Bay TMDL -
"Discharging entities will not be held responsible for uncontrollable coliform discharges originating from wildlife."

We don't know what that contribution is….

To understand the system better, future studies should examine FC, stream discharge volumes, and local precipitation,

- at Headwaters Reserve Parking lot (upstream of all septic sources), above and below Westfall Mazzucchi and at other locations downstream,
- to see if there is a cumulative effect of additional septics and different livestock management, and finally,
- throughout rainy and dry seasons to understand seasonal fluctuations.

Acknowledgements:

- Thanks to Justin Harrison for field and lab work
- Andy and Sandy Westfall and Peter Bussman for access and advice
- Kate Sullivan for sharing wet weather discharge data
- HSU Nielson Family Biological Trust for research support

Questions?

Good References to learn more about Microbial Source Tracking

EPA - Microbial Source Tracking Guide Document
http://www.ces.purdue.edu/waterquality/resources/MSTGuide.pdf

Microbial Source Tracking and the TMDL (Total Maximum Daily Loads) Process http://pubs.ext.vt.edu/442/442-554/442-554.html

Utility of Microbial Source-Tracking Markers for Assessing Fecal Contamination in the Portage River Watershed, Northwestern Ohio, 2008 http://pubs.usgs.gov/sir/2010/5036/

Relative Decay of *Bacteroidales* Microbial Source Tracking Markers and Cultivated *Escherichia coli* in Freshwater Microcosms
http://aem.asm.org/cgi/content/abstract/76/10/3255