Irrigated Pastures and Water Quality


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Pasture water quality questions

- What is the quality of runoff from irrigated pasture?
- How does pasture management effect runoff water quality?
- If there is a problem, what management alternatives are effective at improving runoff water quality?

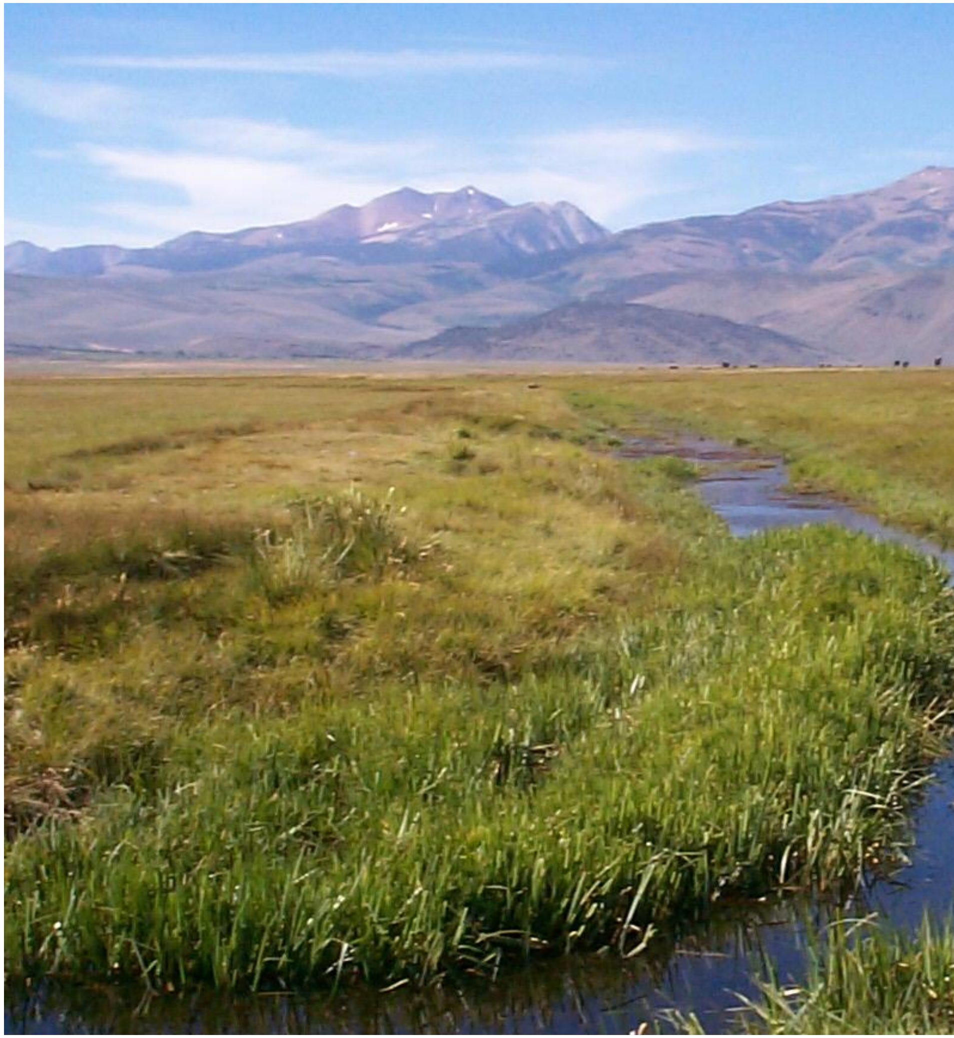
A Series of Experiments

- Surveys of stream water quality changes.
- Stream and tail-water quality response to grazing and irrigation management.
- Vegetative buffers and wetlands as filters.
- Management of buffers and wetlands.

Central Valley Irrigated Pastures

Foothill Irrigated Pastures

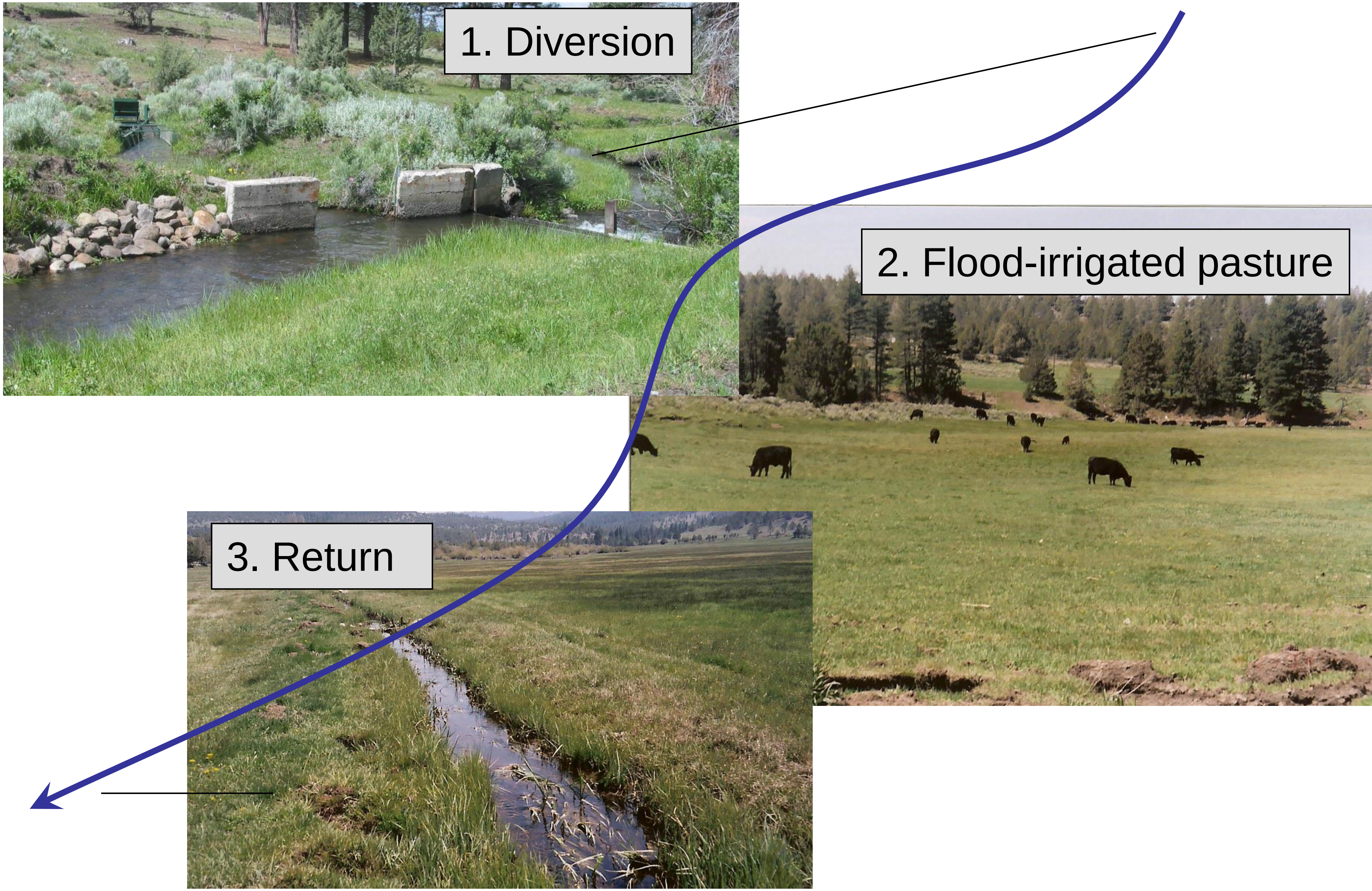
Irrigated Mountain Meadows



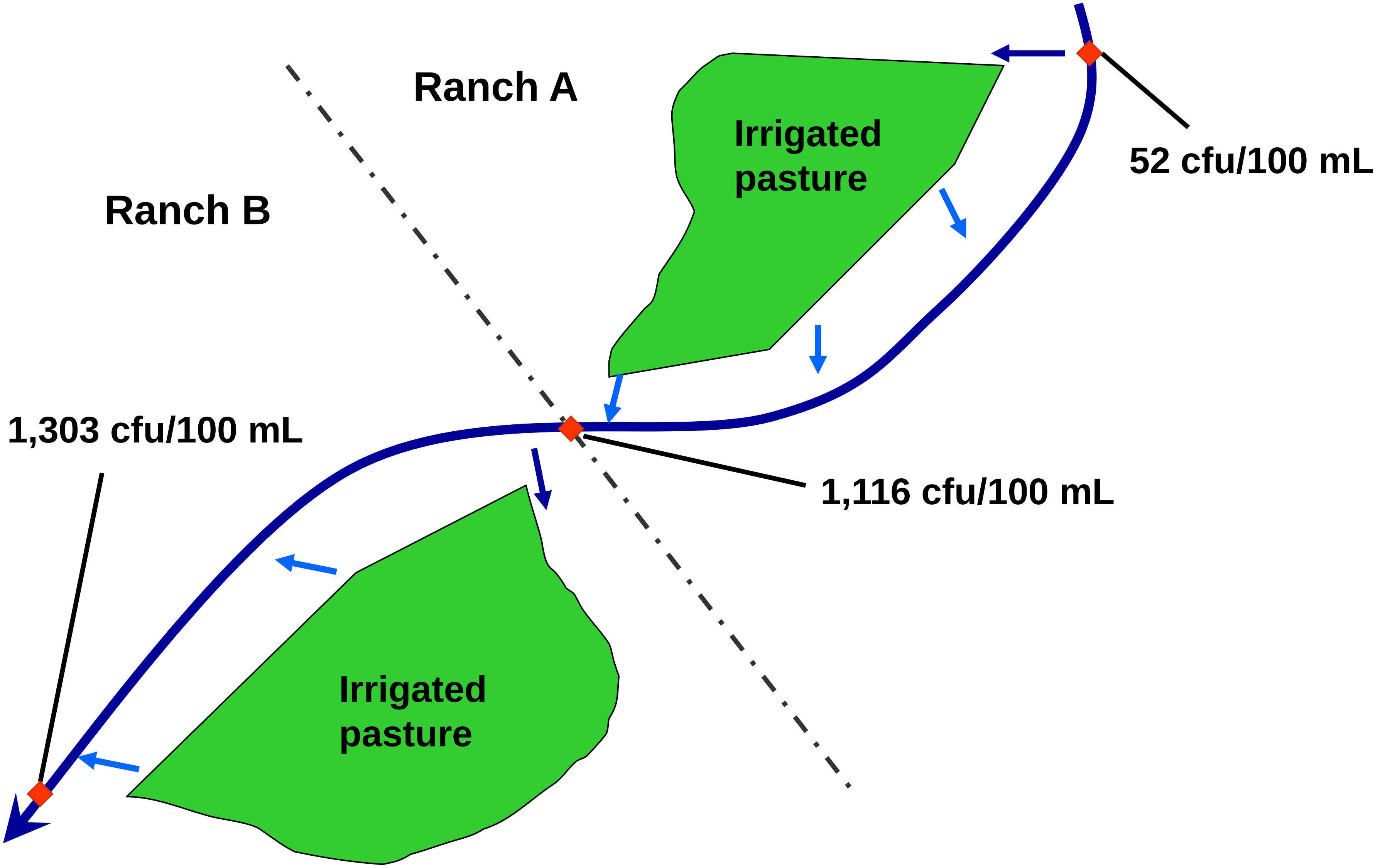
2004 Irrigated Meadow Survey

- **Monitored stream water quality above and below 10 irrigated meadow systems in Modoc and Lassen County.**
- **Assess WQ impact of typical systems.**
- **ID risk factors – solutions.**

Stream diversion based irrigated meadows and pasture



Classic above v. below monitoring



Change in Concentration (Below – Above)

Stream	*E. coli*	TSS	E.C.
1	-1036	-2.3	22.0
2	-233	-2.0	-0.1
3	-182	2.2	24.6
4	10	-5.5	2.7
5	11	4.5	54.0
6	12	-1.9	0.2
7	21	0.0	0.1
8	88	1.0	8.2
9	230	1.4	8.4
10	1064	2.8	2.3

Change: below - above

Stream	*E. coli*
1	-1036
2	-233
3	-182
4	10
5	11
6	12
7	21
8	88
9	230
10	1064

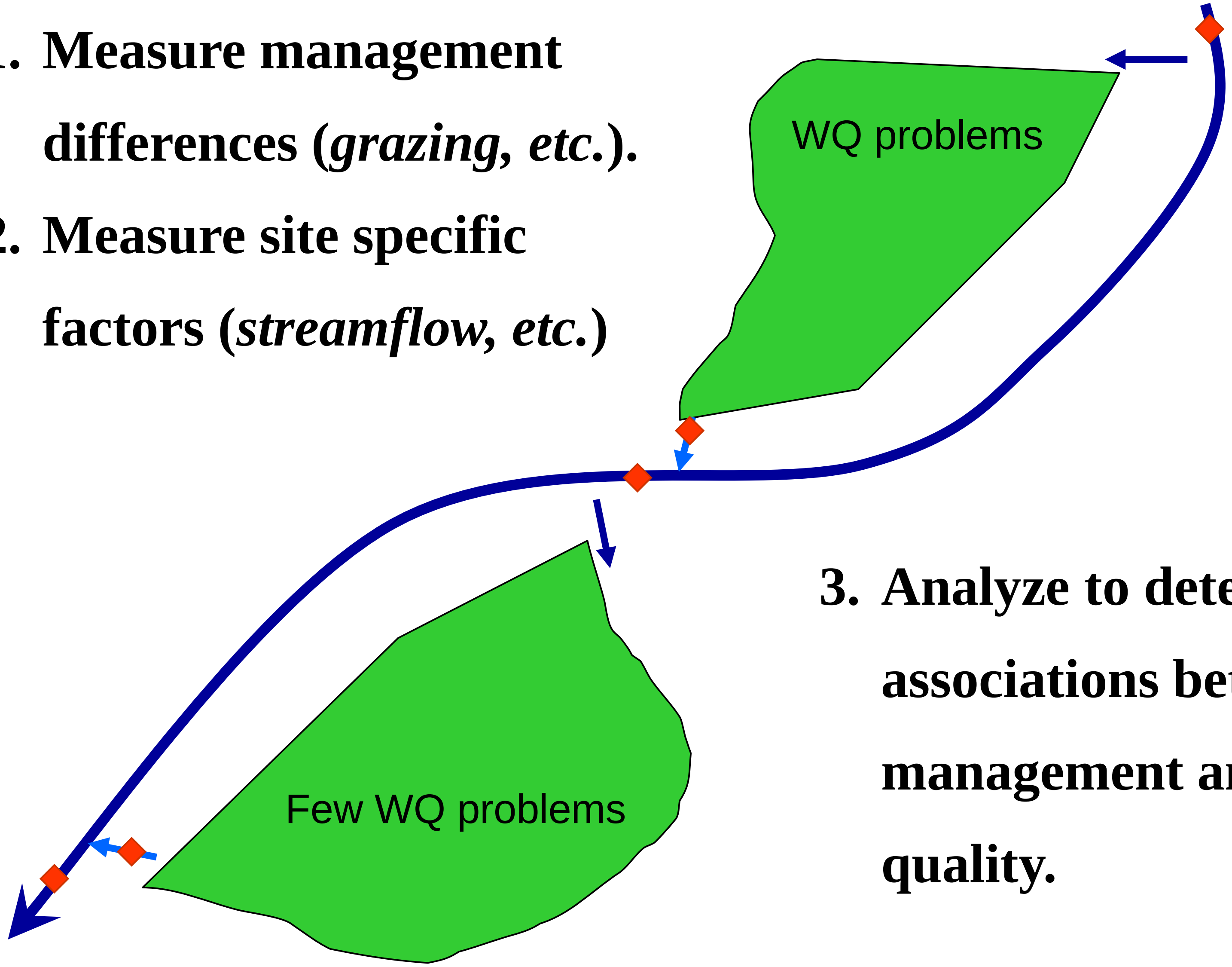
Sink

No change

Source

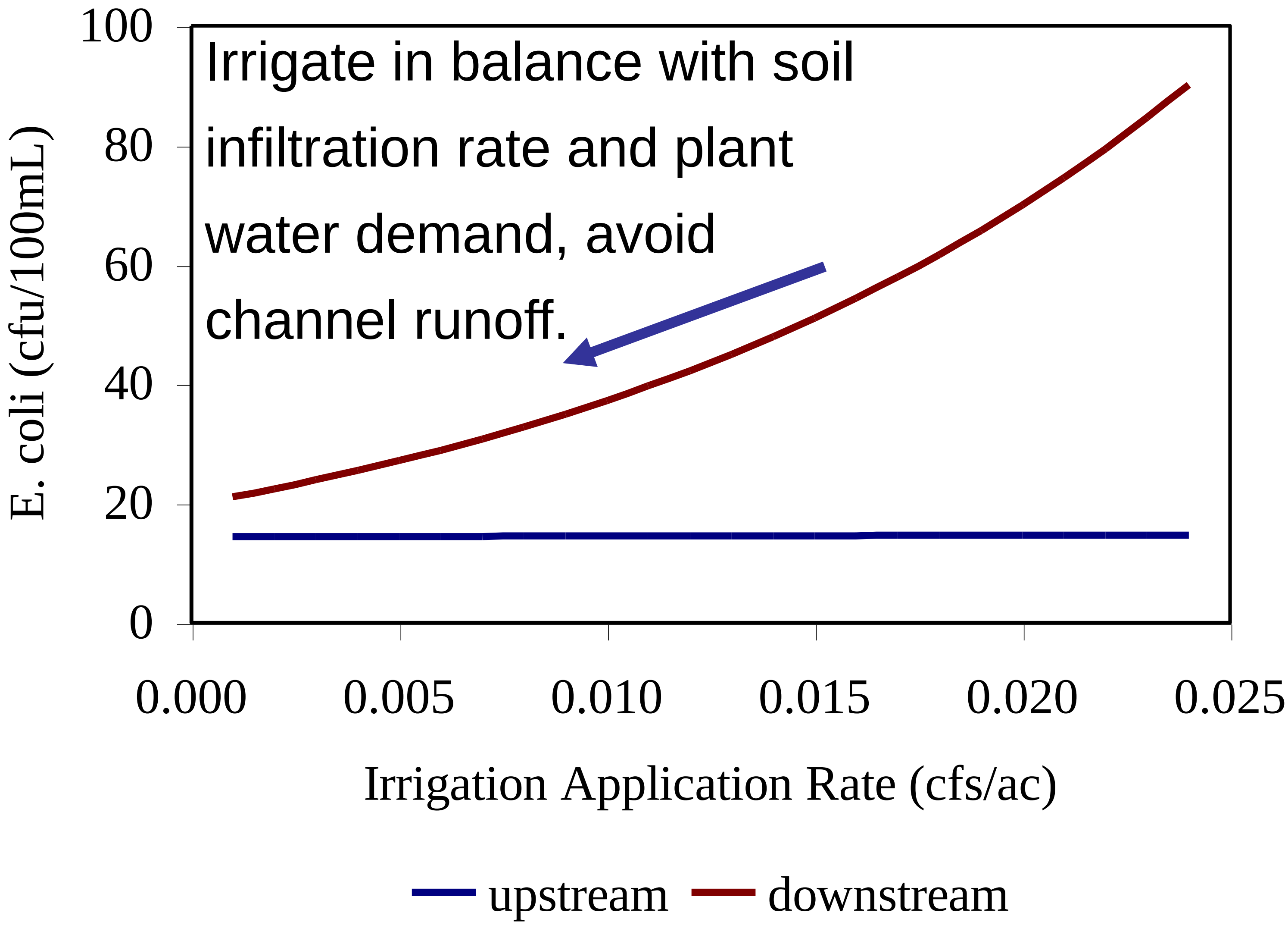
Why does one pasture increase concentrations, while another does not?

1. **Measure management differences (*grazing, etc.*).**
2. **Measure site specific factors (*streamflow, etc.*)**

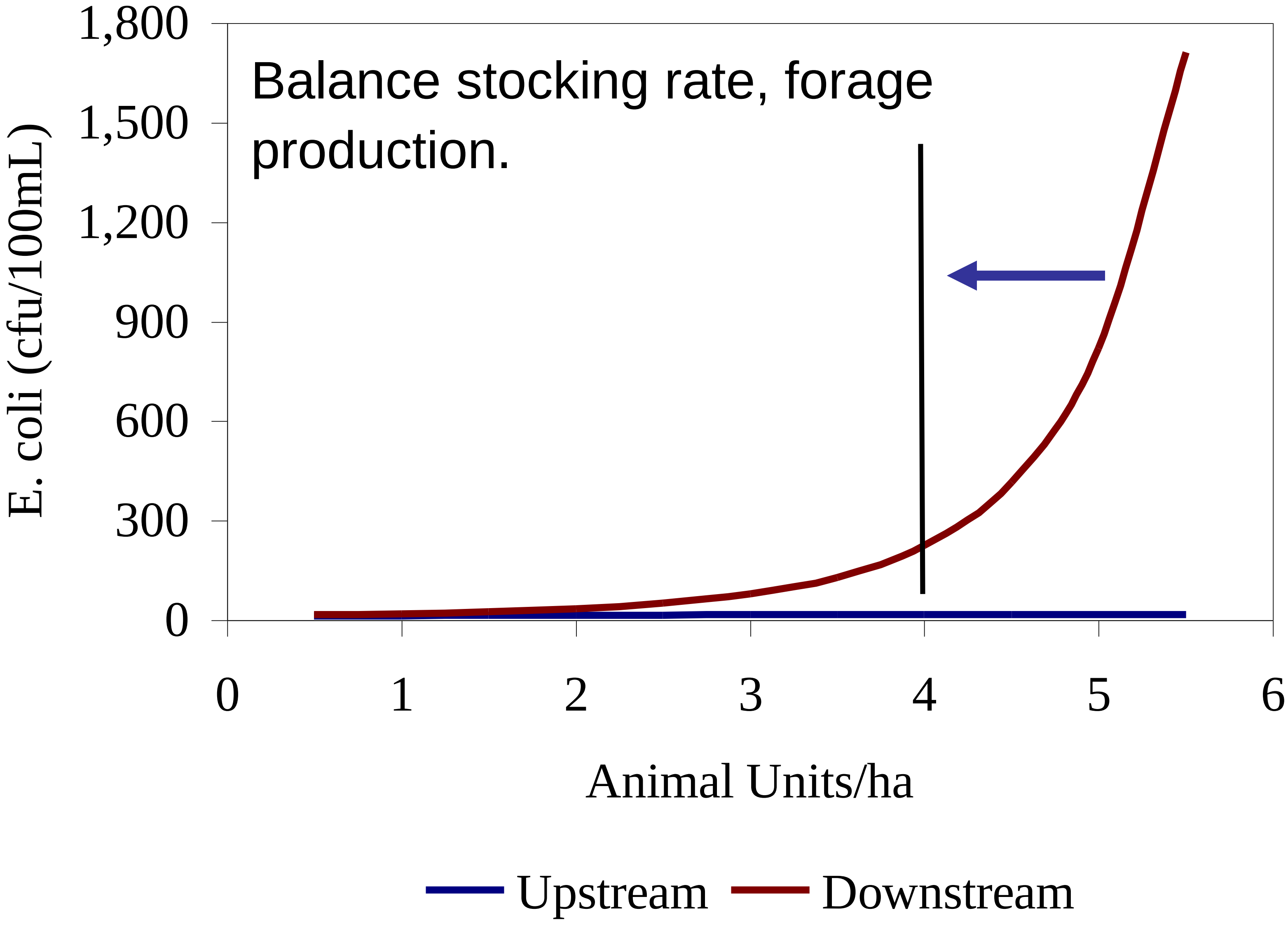


3. **Analyze to determine associations between management and water quality.**

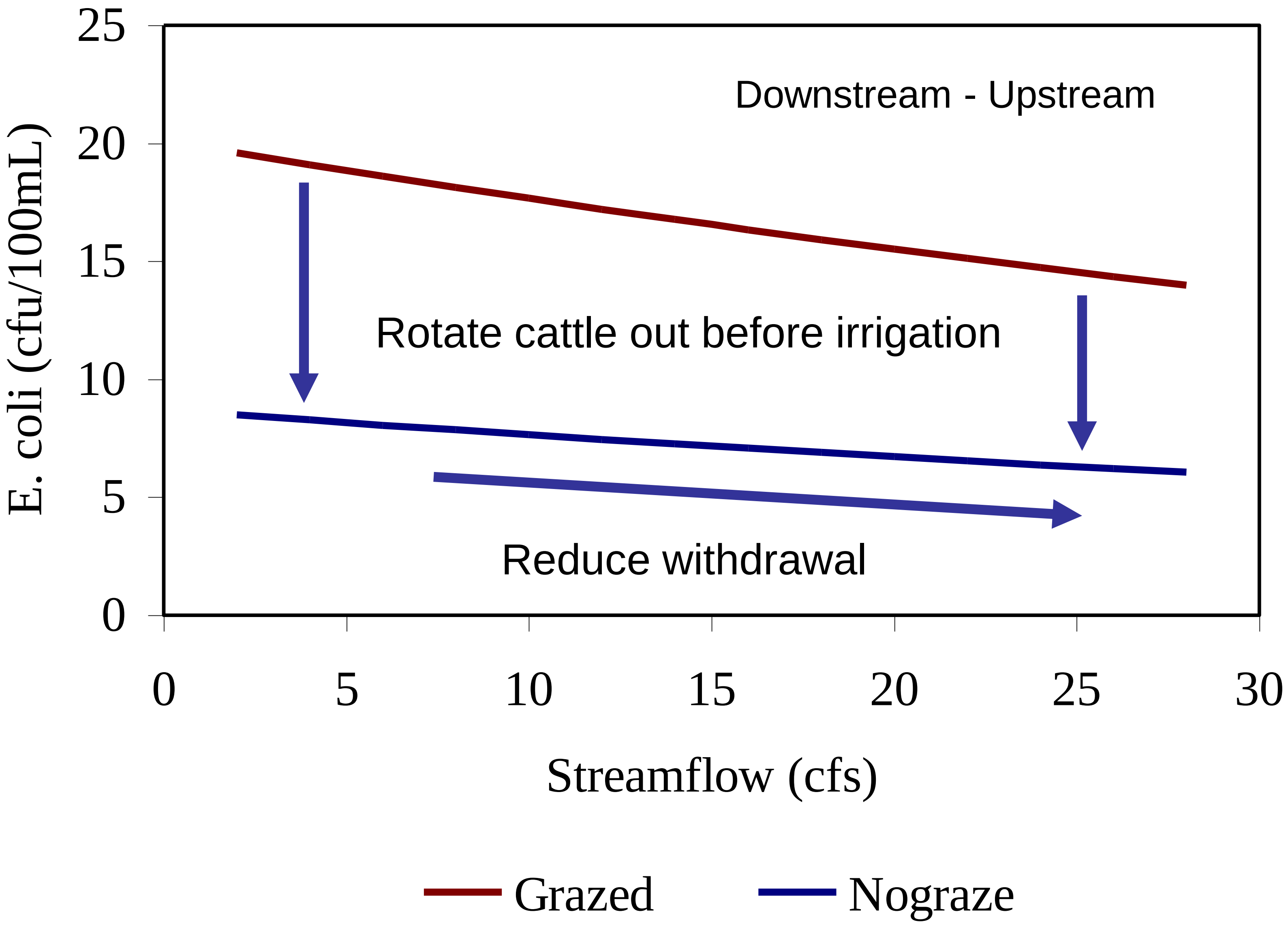
Irrigation Application Rate – Runoff Rate



Cattle Stocking Density (AU = 1 cow)



Rotational Grazing and Diversion Rate

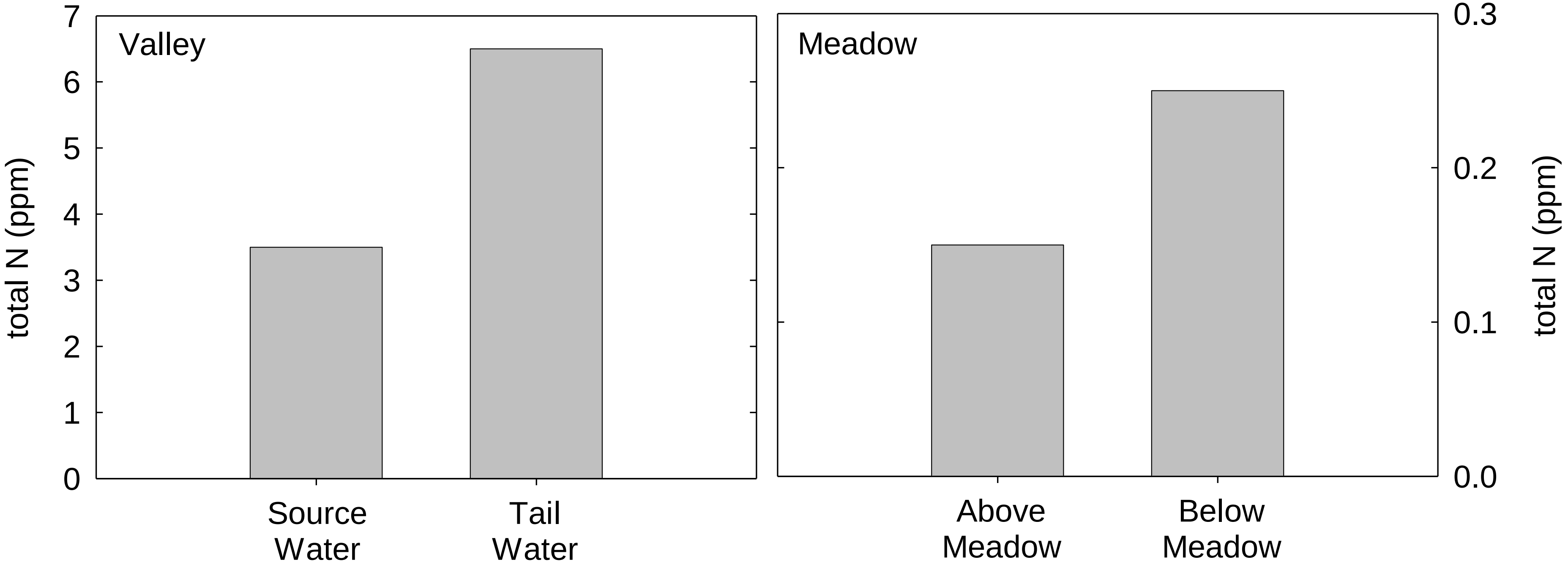


2005 Survey of 10 Valley Pastures, 10 Meadows

- **Monitored stream water quality above and below 10 irrigated pasture systems in Sac. Valley and 10 irrigated meadow systems in NE Calif.**
- **Assess WQ impact of typical systems.**

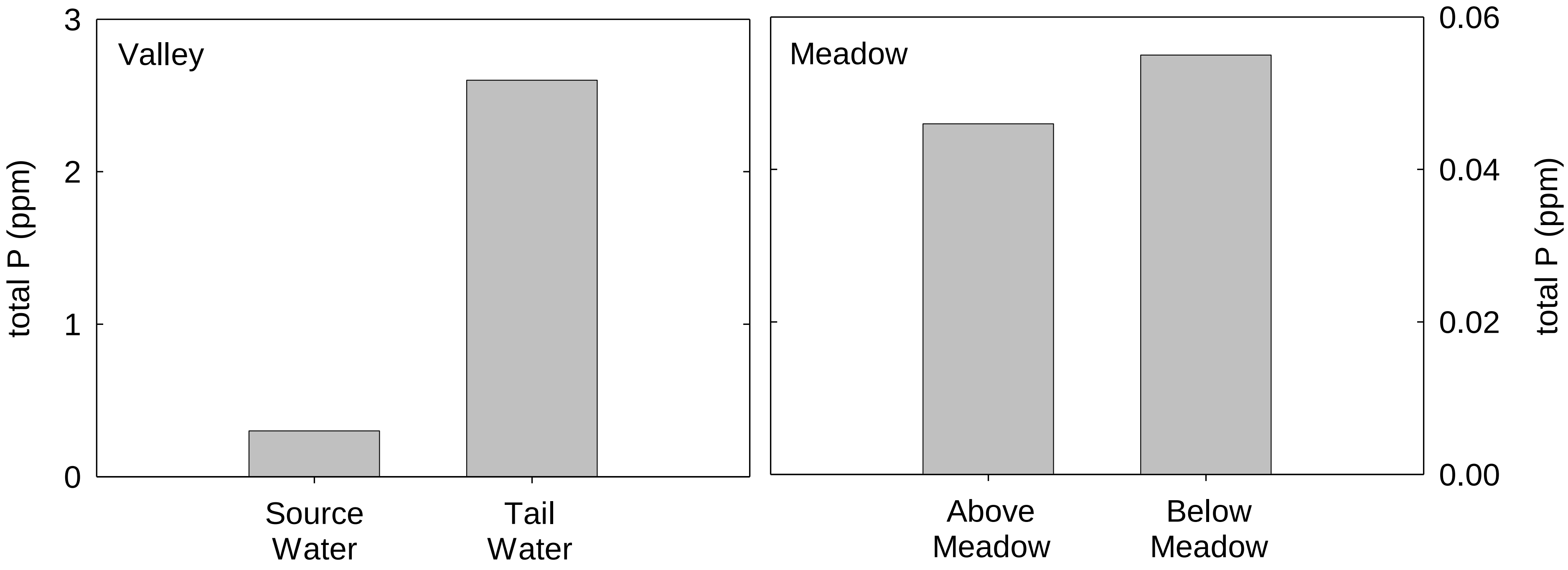
2005 Survey of 10 Valley Pastures, 10 Meadows

Total Nitrogen Concentrations



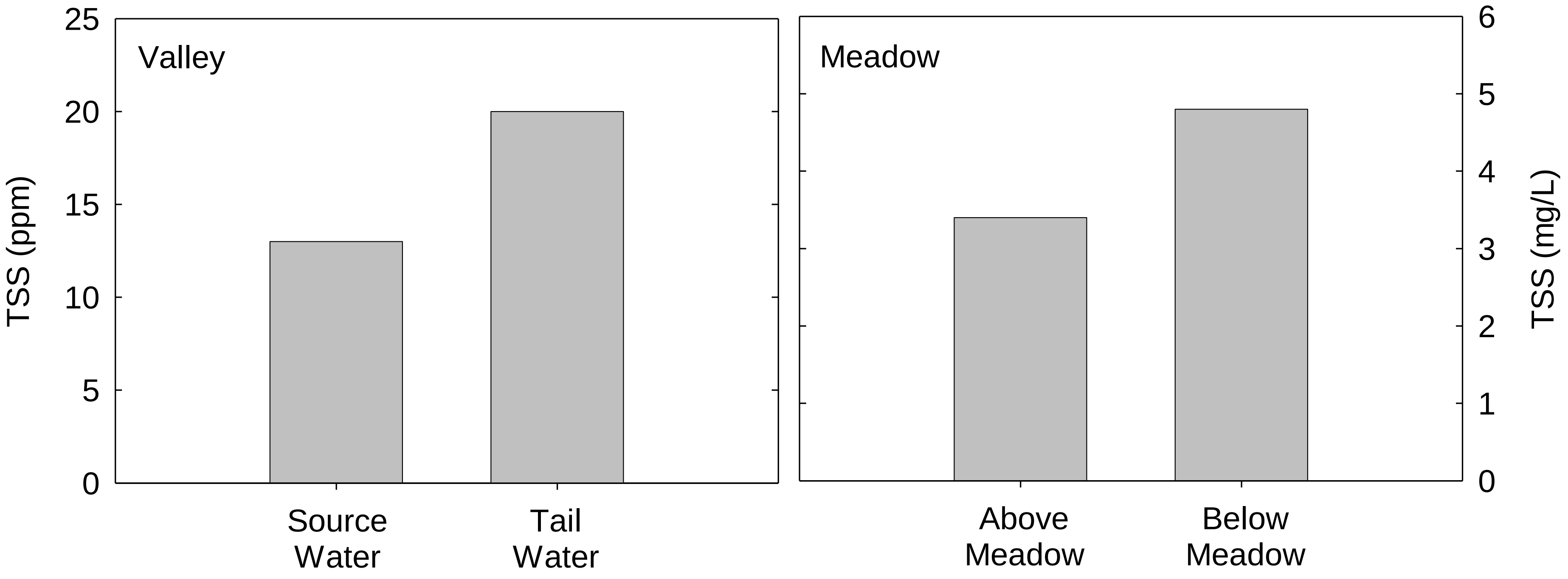
2005 Survey of 10 Valley Pastures, 10 Meadows

Total Phosphorus Concentrations



2005 Survey of 10 Valley Pastures, 10 Meadows

Total Suspended Solids Concentrations



2005 Survey of 10 Valley Pastures, 10 Meadows

Valley Flood Irrigated Pasture (mean concentrations)

Nutrient (ppm)	Source Water	Tail-water
PO_4	**0.21**	**1.82** (PO_4-P = 0.59)
NO_3	**1.60**	**1.22** (NO_3-N = 0.28)
NH_4	**0.18**	**1.84** (NH_3-N ~ 0.009)

Irrigated Mountain Meadow (mean concentrations)

Nutrient (ppm)	Source Water	Tail-water
PO_4	**0.015**	**0.021** (PO_4-P = 0.006)
NO_3	**0.029**	**0.040** (NO_3-N = 0.009)
NH_4	**0.027**	**0.023** (NH_3-N < 0.0001)

UC SFREC

Yuba County

Foothills

Studies of pasture runoff quality in pipe-ditch service delivered water.

Examination of filter strips and wetland buffers to clean runoff.

Concentration of key tail-water quality parameters from irrigated pastures at SFREC. Calculated from ~1,000 discharge water samples across several studies and treatments (2003 through 2009).

Constituent	**Mean**	**Maximum**
E. coli (cfu/100mL)	**10,574**	**538,700**
Nitrate (NO_3 ppm)	0.37	2.05
Ammonium (NH_4 ppm)	0.11	0.2
Total N (ppm)	1.73	4.96
Phosphate (PO_4 ppm)	0.068	0.137
Total P (ppm)	0.139	0.353
Dissolved Organic Carbon (ppm)	**9.51**	**22.21**
Total Suspended Solids (mg/L)	**47.5**	**216**

Vegetative Filter Strips

- Foothill irrigated pasture checks with 0, 8, or 16 m vegetative filter strips.
- Surface applied and tracked ^{15}N ("labelled") in water, soil, plants.

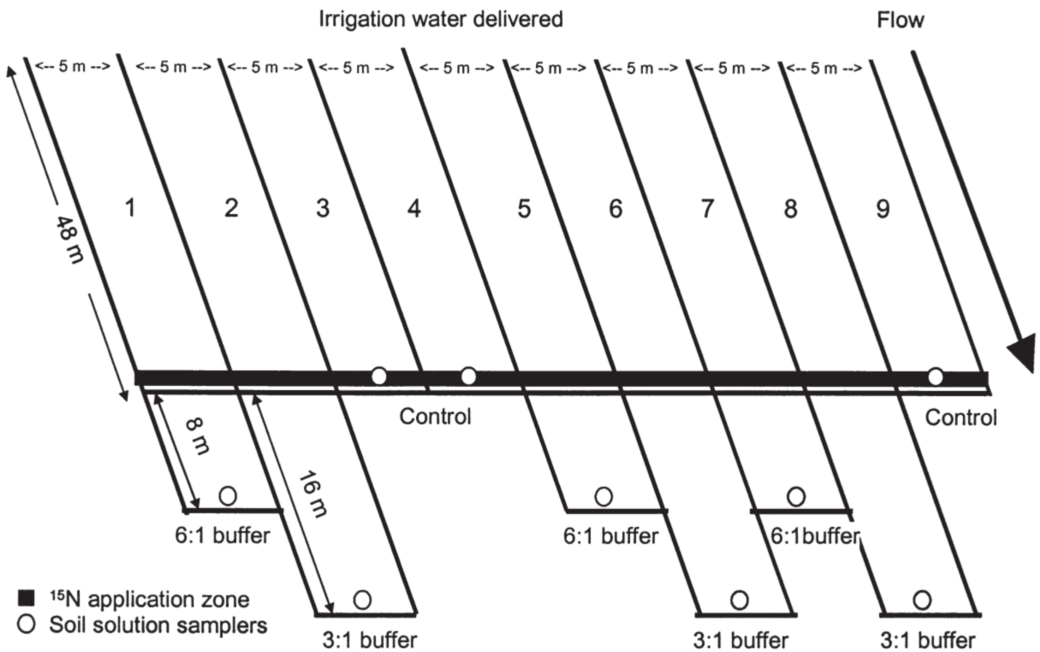


Fig. 1. Schematic of plot design (not to scale). Collection troughs installed at the bottom of each treatment (downslope of solution samplers).

Vegetative Filter Strips

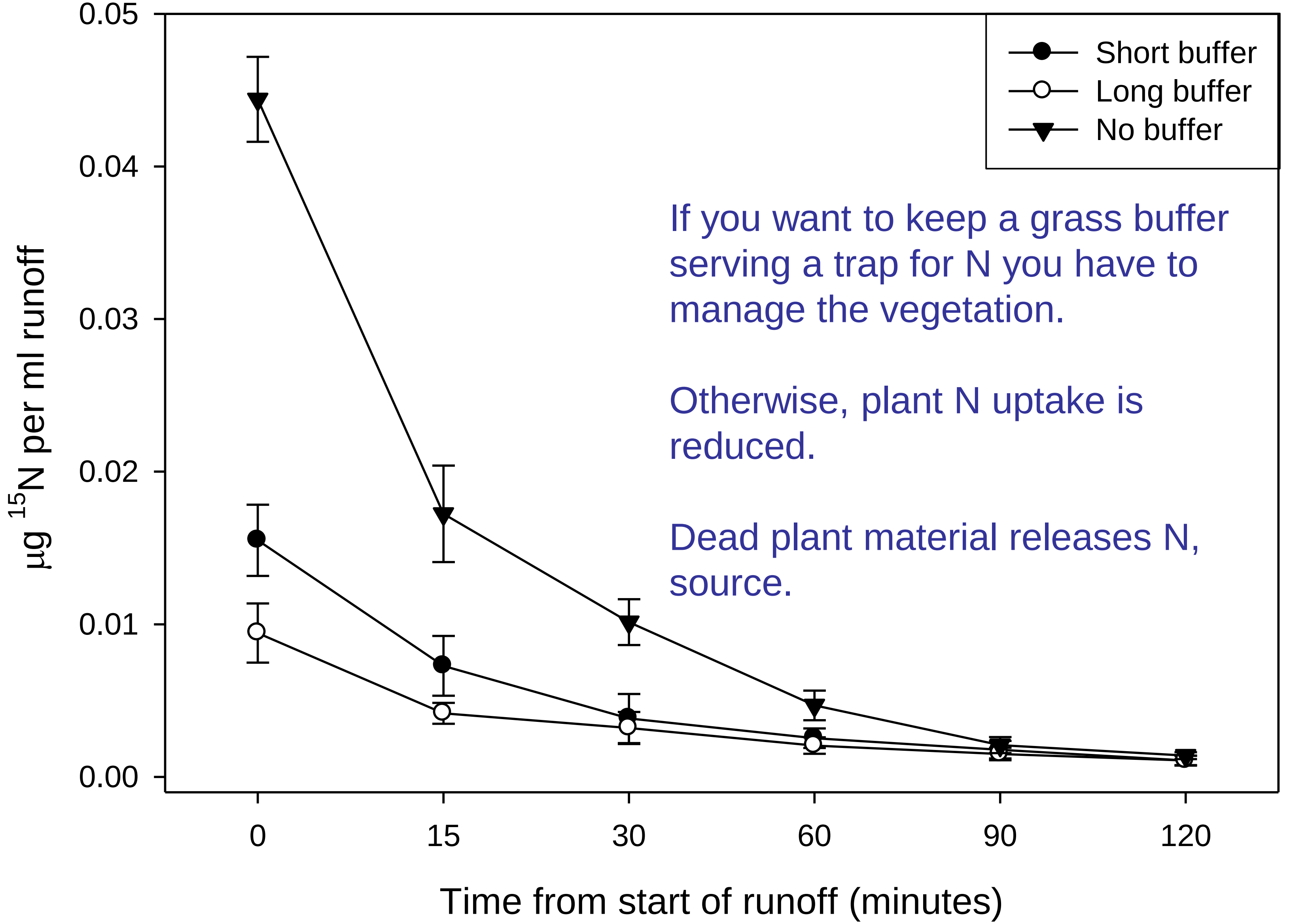
- Foothill irrigated pasture checks with 0, 8, or 16 m vegetative filter strips.
- Surface applied and tracked ^{15}N ("labelled") in water, soil, plants.

N lost as tail-water

Filter Treatment	NO_3 Reduction (%)	NH_4 Reduction (%)
None	0	0
8 meter	28	42
16 meter	34	48

- Substantial plant uptake of new N in the application zone (pasture) 50% within first 10 days following application.
- 25% stored in soil in the application zone.
- Most N sequestration occurred in the first 4 m of buffer.
- Only 3% of applied left plots as runoff – mostly as plant unavailable DON.

^{15}N concentration in runoff during first irrigation following application



If you want to keep a grass buffer serving a trap for N you have to manage the vegetation.

Otherwise, plant N uptake is reduced.

Dead plant material releases N, source.

Can we use natural and augmented wetlands to filter runoff from pastures?

How do we manage them?

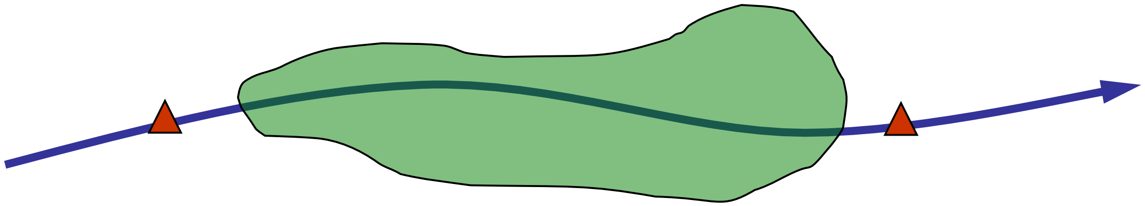
An opportunity to filter water from multiple fields, or at the end of a series of pastures.

Measure streamflow and water quality in and out of 2 wetlands at SFREC.

One somewhat channelized, 1 wetland with even distribution of flow.

3 irrigation application rates ~0.7, 1.7, and 2.5 cfs/ac.

Pasture’s grazed prior to each irrigation trial (n=6).

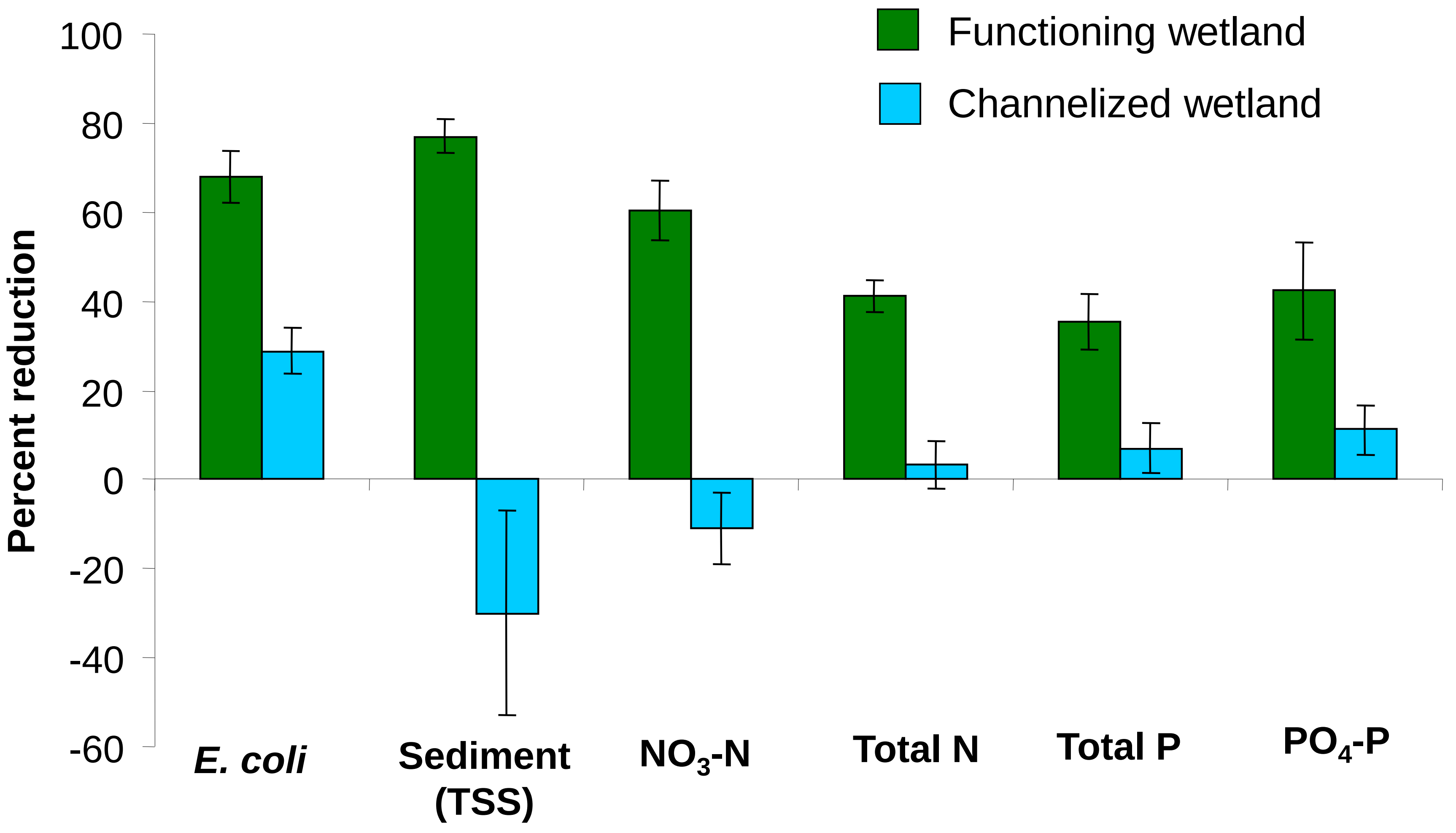


Effectiveness is dependent on flow dispersion, infiltration, and residence time

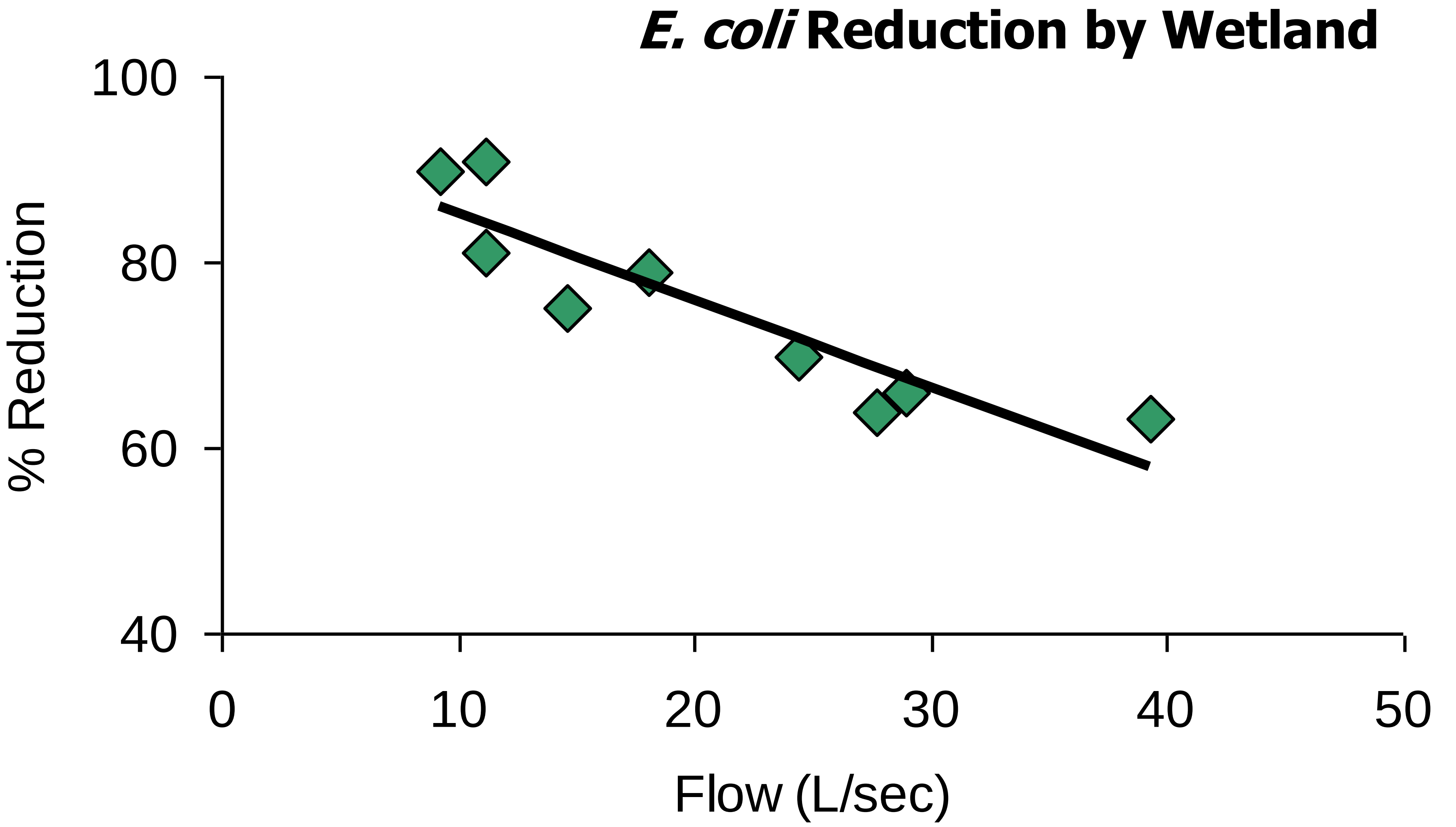
Functioning Wetland

Channelized Wetland

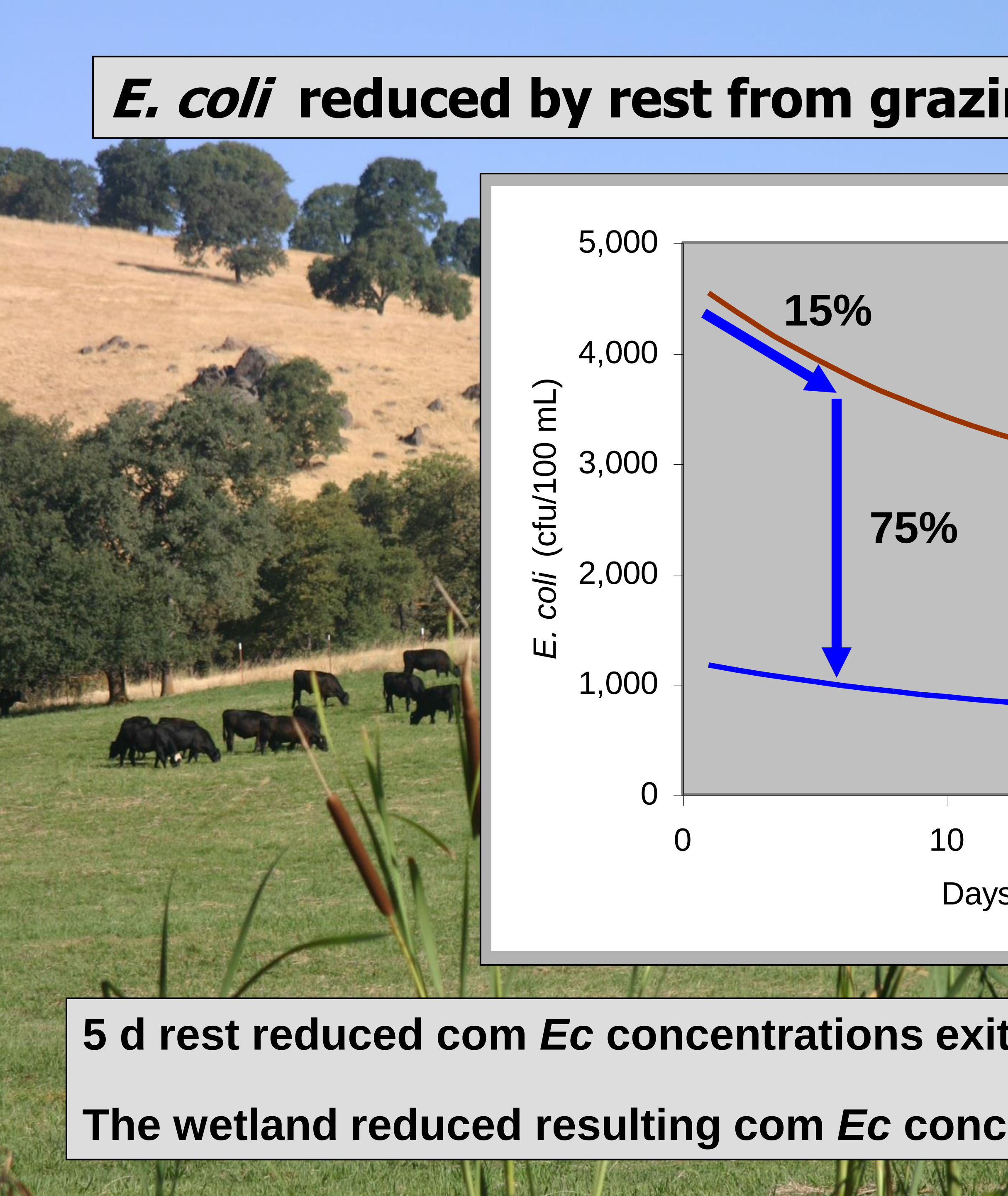
Reduction of Pollutants due to Wetland

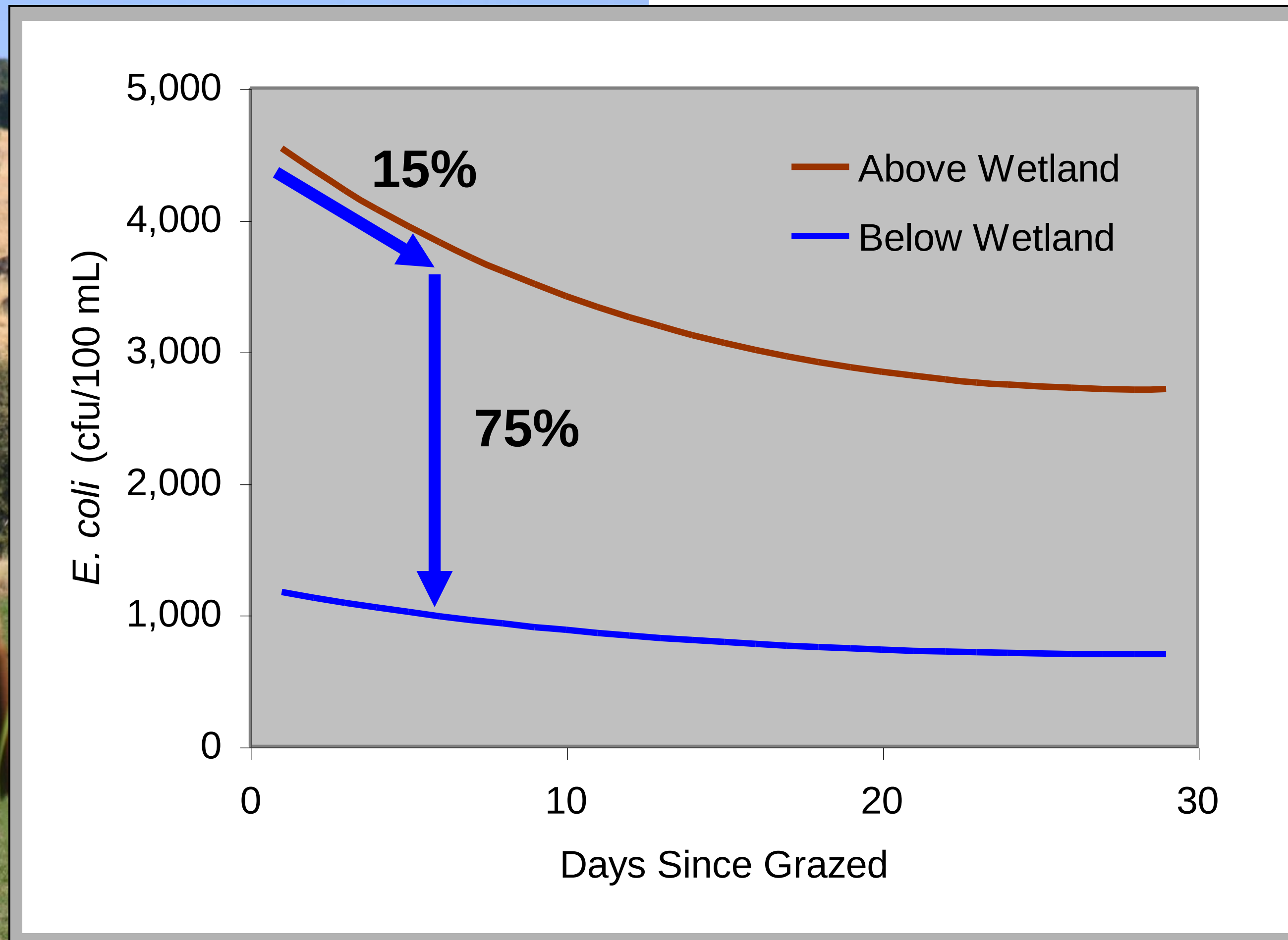


Less Filtration Under High Flow Conditions



E. coli reduced by rest from grazing before irrigation

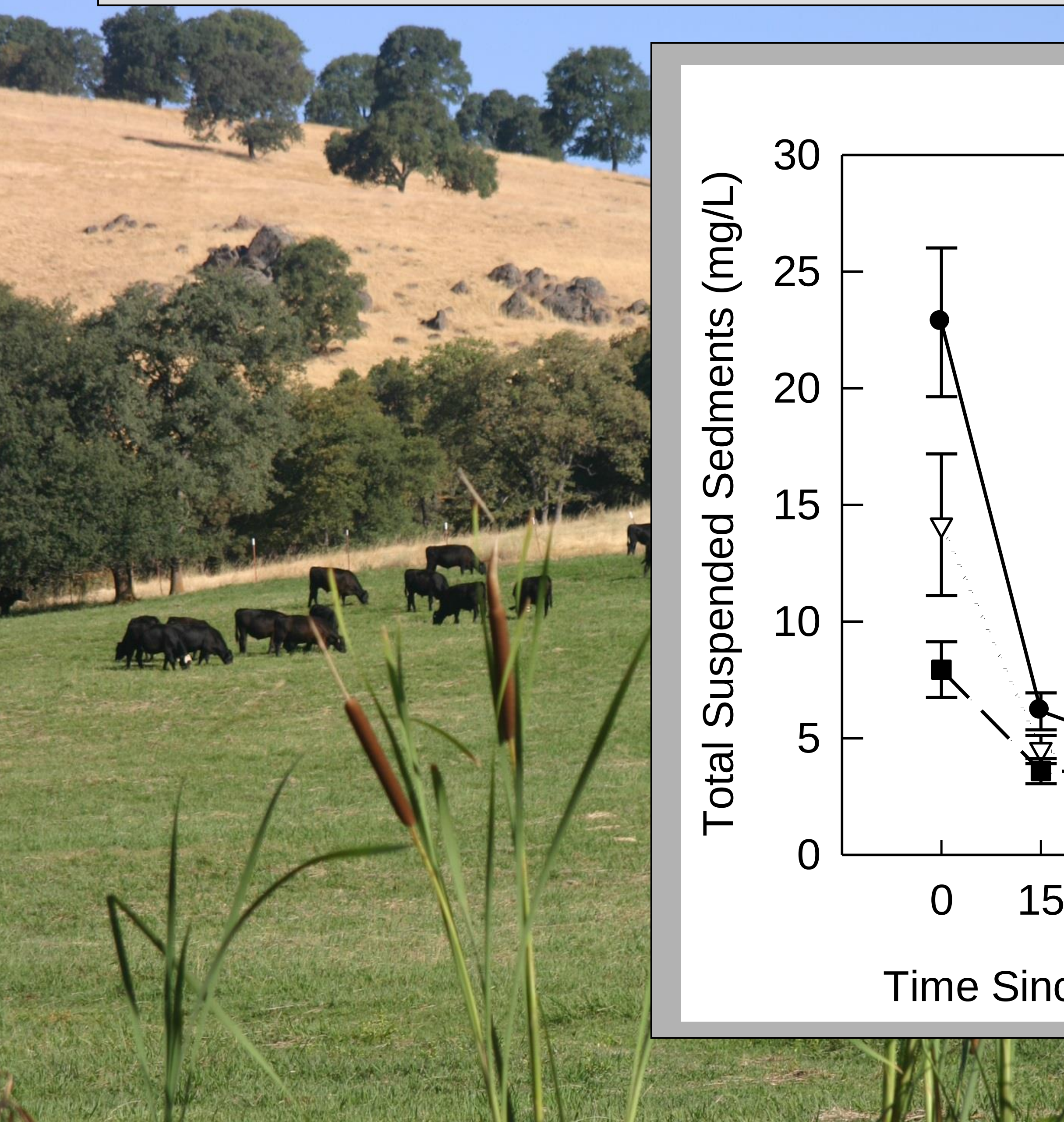


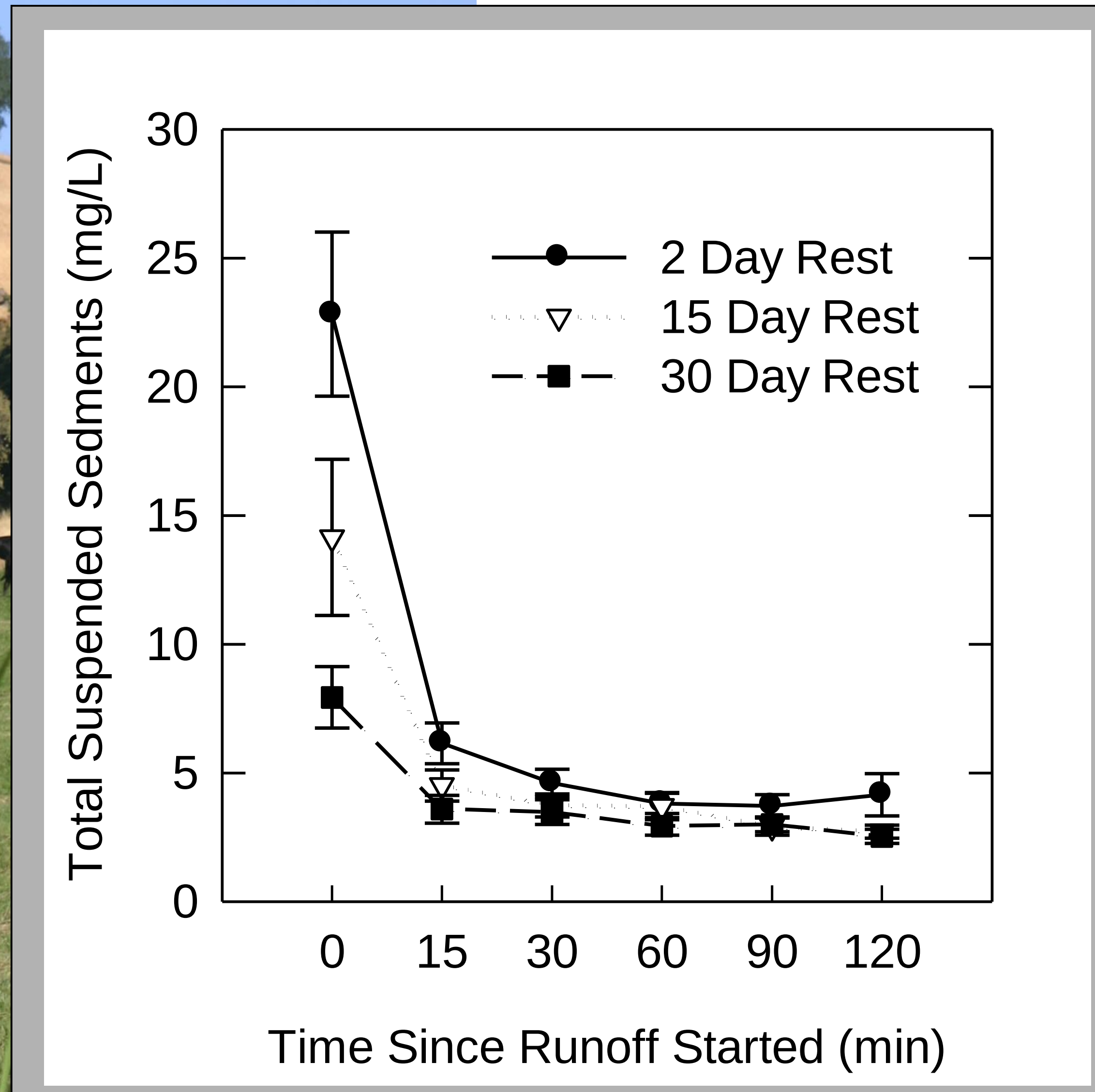


5 d rest reduced com *Ec* concentrations exiting pasture by 15%

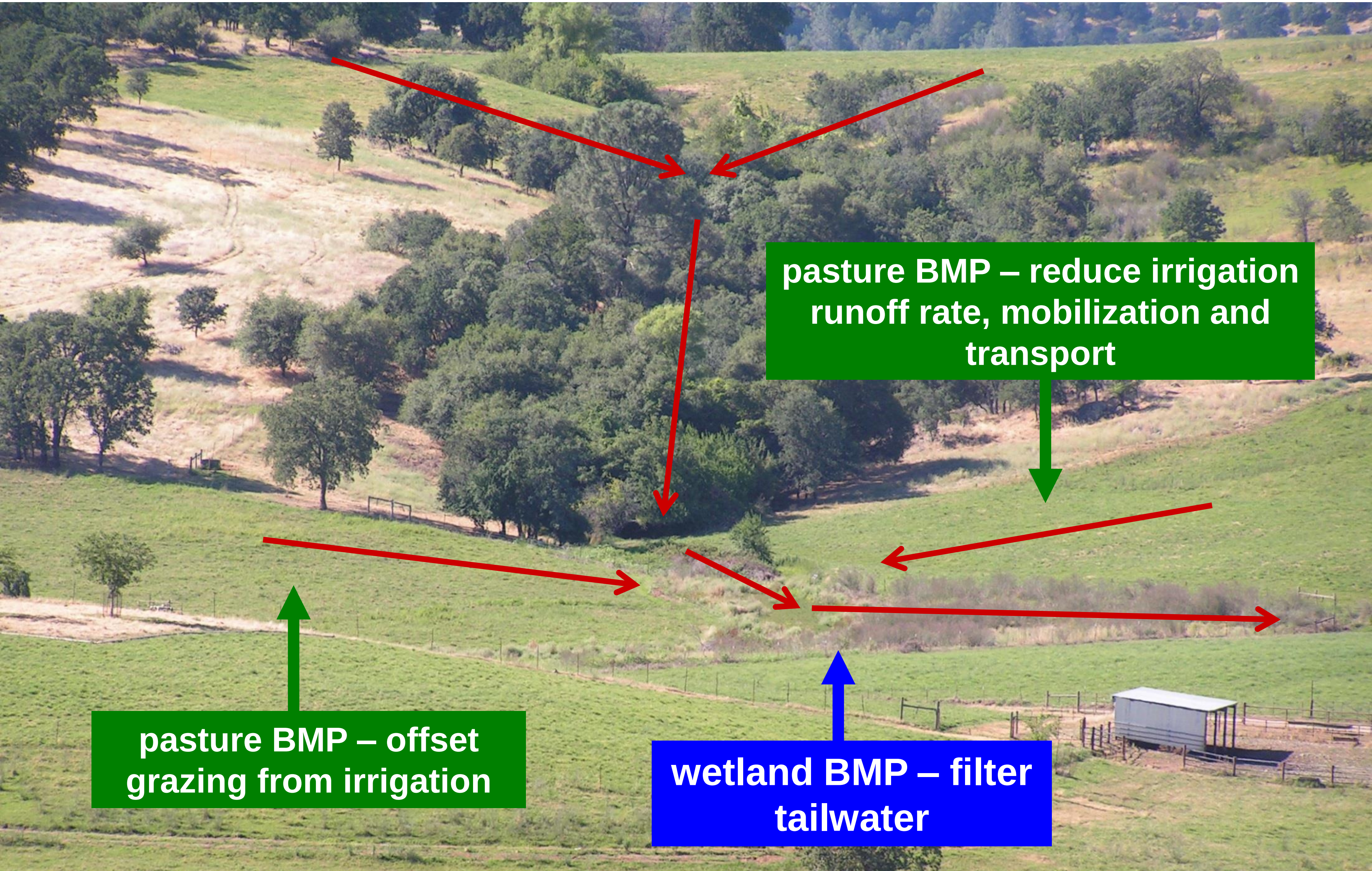
The wetland reduced resulting com *Ec* concentration by another 75%

TSS reduced by rest from grazing before irrigation





Case Study – Irrigated Foothill Pasture



Buffer Effectiveness

- Vegetative buffer strips can be effective at cleaning runoff from irrigated pasture.
- Effectiveness is greatly diminished under high runoff rates – transport energy too great.
- Vegetation must be managed.

Summary

- Irrigated pasture could be a WQ issue, certainly not always.
- Reduced tail-water generation and rates a key WQ improvement practice.
- Productive pasture management will very likely reduce WQ risk, and increase profit.
- Several management options are available if there is a problem.
- Apply them in an integrated manner for overall cumulative reductions.

Summary

- http://stream.ucanr.org/irrigated_pasture_review/index.html
- http://rangelandwatersheds.ucdavis.edu/

Supporting Research

- Popova, I.E., D.A. Bair, K.W. Tate, and S.J. Parikh. 2013. Sorption, Leaching, and Surface Runoff of Beef Cattle Veterinary Pharmaceuticals under Simulated Irrigated Pasture Conditions. 2013. J. Environmental Quality. 42:1167-1175.
- Knox, A.K, R.A. Dahlgren, K.W. Tate, and E.R. Atwill. 2008. Efficacy of Flow-Through Wetlands to Retain Nutrient, Sediment, and Microbial Pollutants. J. Environmental Quality. 37:1837-1846.
- Knox, A.K., K.W. Tate, R.A. Dahlgren, and E.R. Atwill. 2007. Management Reduces *E. coli* in Irrigated Pasture Runoff. California Agriculture. 61:159-165.
- Tate, K.W., D.L. Lancaster, J. Morrison, and D.F. Lile. 2005. Monitoring Helps Reduce Water Quality Impacts in Flood Irrigated Pasture. California Agriculture. 59:168-175.
- Bedard-Haughn, A., K.W. Tate, C. van Kessel. 2005. Quantifying the Impact of Regular Cutting on Vegetative Buffer Efficacy for ^{15}N sequestration. J. Environmental Quality. 34:1651-1664.
- Bedard-Haughn, A., K.W. Tate, C. van Kessel. 2004. Using ^{15}N to Quantify Vegetative Buffer Effectiveness for Sequestering N in Runoff. J. Environmental Quality. 33:2252-2262.