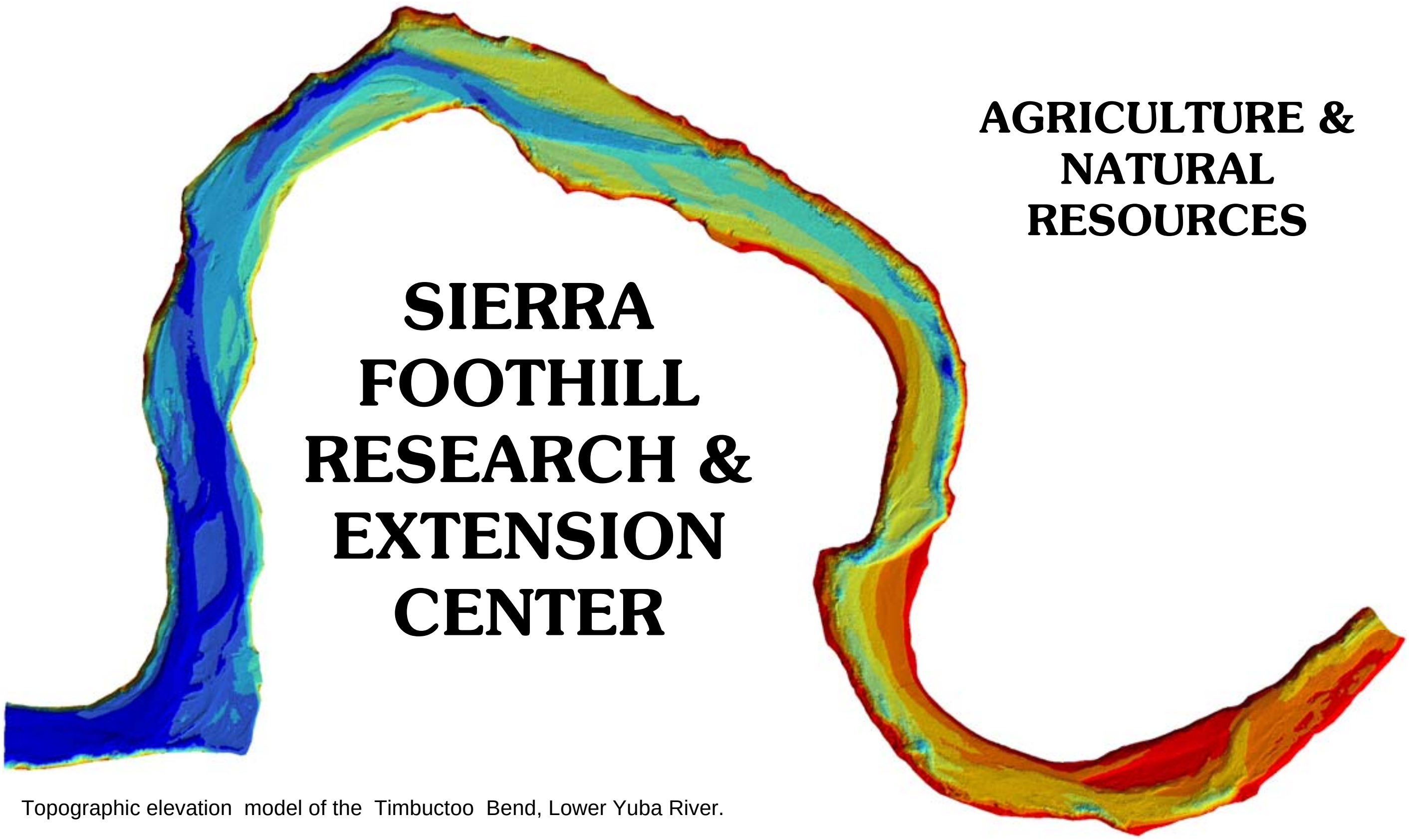
THE UNIVERSITY OF CALIFORNIA

AGRICULTURE & NATURAL RESOURCES

SIERRA FOOTHILL RESEARCH & EXTENSION CENTER



Topographic elevation model of the Timbuctoo Bend, Lower Yuba River.

Yuba upstream of UC Picnic Site. Oct 12, 2005. Approx 950 cfs

Beef and Range Field Day: Natural Resources

Yuba upstream of UC Picnic Site. Dec 31, 2005. Approx 110,000 cfs

APRIL 19, 2007

Browns Valley, California

Elevation model generated from 2006 Survey by the Pasternack Watershed Hydrology Lab, UCDavis.
Photos Provided by the Pasternack Lab

Photograph courtesy of GlobeXplorer

UNIVERSITY OF CALIFORNIA
AGRICULTURE & NATURAL RESOURCES

SIERRA FOOTHILL RESEARCH & EXTENSION CENTER

Presents:

Annual Beef & Range Field Day

APRIL 19, 2007

In Cooperation With:
Ecosystem Sciences, UC Berkeley
Dept. of Plant Sciences, UC Davis
Land, Air & Water Resources, UC Davis
School of Veterinary Medicine, UC Davis
Ecology & Evolutionary Biology, UC Irvine
California Rangeland Conservation Coalition

BEEF & RANGE FIELD DAY:
NATURAL RESOURCES

UC Sierra Foothill Research & Extension Center
APRIL 19, 2007

A G E N D A

Registration: 9:00-9:30am -- $15.00 (Includes proceedings, refreshments & lunch)

Morning Moderator – Roger Ingram, UCCE Livestock Advisor Placer/Nevada Counties

9:30am	**Welcome and Introductions –** Art Craigmill, Director, SFREC
9:35am	**Fish spawning and channel change patterns on the dynamic lower Yuba River --** Greg Pasternack, Land Air Water Resources, UC Davis
9:55am	**What are the effects of rainfall change on rangeland productivity and soil carbon?** Wendy Chou, Ecosystems Sciences, UC Berkeley
10:15am	**Effects of prescribed fire on oak woodland soil landscapes** -- Toby O'Geen, Land Air Water Resources, UC Davis
10:35am	**California Rangeland Conservation Coalition *PANEL*** -- Tracy Schohr, CCA and Theresa Becchetti, UCCE
11:30am	**Tri-tip BBQ Lunch** – Served by the Yuba-Sutter Cowbelles & SFREC Staff
	During Lunch: California Cattlemen's Association Officers: **Industry Update**

Afternoon Moderator – Glenn Nader, UCCE Livestock Advisor, Butte/Sutter/Yuba Counties

12:50pm	Travel to Porter
1:00pm	**Enhancing natural oak regeneration --** Doug McCreary (UC Berkeley-SFREC) **Oak regeneration & grazing and overview of state transition model plots --** Stan Harpole, Ecology & Evolutionary Biology, UC Irvine
1:40pm	Travel to Haworth
1:55pm	**Vegetative buffers and wetlands to filter E. coli and other pollutants in runoff from pasture and rangelands --** Ken Tate, Plant Sciences, UC Davis and Rob Atwill, School of Veterinary Medicine, UC Davis
2:50pm	**Black Rails in the Sierra Foothills: Distribution and habitat characteristics** -- Orien Richmond, Ecosystems Sciences, UC Berkeley
3:10pm	Wrap-up -- Charlie Raguse, Professor Emeritus, Plant Sciences, UC Davis

For more information about the Sierra Foothill Research & Extension Center, go to:
http://groups.ucanr.org/sierrafoothill/

Annual Beef & Range Field Day Proceedings
April 19, 2007

LIST OF CONTENTS

Fish spawning and channel change patterns on the dynamic lower Yuba River

G. B. Pasternack, LAWR, UC Davis

A primary goal of the CALFED Ecosystem Restoration Program is to restore naturalized geomorphic dynamics to Central Valley streams to provide for an array of ecological functions. At present the majority of Central Valley streams are so structurally degraded and have such restricted flow regimes, that what might come out of restoration would likely deviate from textbook ideals upon which restoration strategies have been developed. Consequently, it is helpful to identify and evaluate reference streams whose current conditions resemble what future restored streams might actually be like. For example, the 3500-km^2 Yuba River watershed in northern California has experienced extensive anthropogenic disturbance over the past ~150 years due to hydraulic gold mining, dams, and diversions. Nevertheless the large size, dynamic flow regime, and abundant coarse sediment supply on the mainstem Lower Yuba River (LYR) provide just the kind of dynamic geomorphology sought after in many restoration projects. Existing conceptual models for managing natural streams or other degraded Central Valley streams don't fit the LYR, which experienced a once in 8-yr flood of 43,000 cfs and a once in 24-yr flood of 115,000 cfs in back-to-back years 2005-2006. From 2004-2007 my group of students and postdoctoral researchers has been monitoring the hydraulic, geomorphic, and sedimentary conditions in the lower Yuba River between Englebright Dam and the Highway 20 bridge. At the same time we have been observing where salmon choose to spawn in this reach. In this presentation, monitoring data from the LYR will be used to characterize the dynamic geomorphic regime, including evidence of frequent episodes of morphological adjustment. The response of the fish to the physical changes will be explained. Based on these findings, lessons for how CALFED's monitoring and restoration actions might change after an initial wave of restoration projects throughout the Central valley is completed will be discussed.

Carbon Cycling in Annual Grasslands: Effects of Natural Rainfall Variability and a Rainfall Manipulation

Wendy Chou, Whendee Silver, Barbara Allen-Diaz
University of California – Berkeley, Ecosystems Sciences
and additional collaboration with Randy Jackson (U. Wisconsin-Madison)

Objectives

Conservation of the soil carbon resource conserves soil fertility and promotes ecosystem sustainability. Understanding the response of soil carbon cycling to future climate change is of paramount importance. Especially critical is the study of potential feedback loops between soil respiration, a large natural CO_2 release pathway, and future climate change. The main objective of this project was to determine whether soil carbon in annual grasslands would increase or decrease under an augmented rainfall regime (expected under certain climate change scenarios). We assessed this question by measuring net primary productivity and soil respiration for three complete years in annual grassland under 50 % increased rainfall versus ambient rainfall conditions. We also sought to characterize the relationship between soil moisture, temperature, and soil respiration for water-limited annual grassland systems, focusing on the greater importance of the timing (as opposed to quantity) of water inputs in this highly seasonal environment.

Approach

Each experimental block consisted of an irrigated plot and an unmanipulated control plot, separated by a buffer strip 15 m wide. Plots were 15 × 30 m each. Each year, irrigated plots received a simulated rainfall event in early fall and a second simulated rainfall event in late spring. These early- and late-season "wet-up" events each delivered approximately 20 mm (0.79 in) rainfall over ~7 hours via microsprinklers. Fall wet-up events took place approximately 1 to 3 weeks before the start of the rainy season, and were substantial enough to trigger seedling germination 3 to 4 days after wet-up. Late-season wet-ups took place approximately 4 weeks after the end of the rainy season. Microsprinklers were mounted to 4 ft tall stakes arrayed in a grid throughout the plot and irrigated in a 360° pattern.

During the wet season, a grid of microsprinklers was automatically operated by a datalogger recording rainfall in real-time, which opened a 12 VDC-operated valve upstream of the sprinklers for a time interval proportional to hourly rainfall, increasing the natural rainfall by 50%. Irrigation water was supplied from a nearby lake and filtered before entering the irrigation system. When heavy rainfall exceeded the maximum delivery rate of the automated system, any deficit in irrigation was fulfilled by operating sprinklers manually.

We measured soil moisture, temperature, bulk density, soil respiration (using a LI-COR 6400), annual net primary productivity (both above- and belowground), for three complete "water years" (defined as September 1 to August 31).

Key Findings

1. **Grassland soil respiration responded rapidly to wet-up events** applied before and after the bounds of the natural rainy season. These wet-up events resulted in substantial increases in soil moisture (Fig. 1b) and large pulses of soil CO_2 across the soil-atmosphere interface lasting for several days (Table 1). CO_2 fluxes declined following an exponential decay pattern (Figure 2). Maximum fluxes were observed in the fall wet-up, presumably because prolonged summer drought followed by sudden changes in water potential stressed soil heterotrophic microorganisms and led to the release of highly labile carbon substrates.

2. **Augmenting rainfall by 50 % had a muted effect on soil respiration**, with a significant response only in one of three years (Figure 3). Because most of the experimental rainfall was applied in the cool, wet season, we suspect that moisture was already abundant and low temperatures were more limiting to soil respiration.

3. **Changes in the seasonal timing of rainfall significantly affected soil respiration**: abundant rainfall late in the wet season in WY 04, a year with average total rainfall, led to greater net ecosystem C losses due to a ~50 % increase in soil respiration relative to other years (1480 ± 152 g C/m^2/y, relative to 1011 ± 42 or 918 ± 73 g C/m^2/y; Figure 4). Our results suggest that C cycling in annual grasslands will be more sensitive to altered rainfall distribution, rather than rainfall intensity, and that a longer or later wet season will result in significant C losses from annual grasslands.

4. **Net primary productivity did increase with increasing rainfall**, in contrast to soil respiration (Figure 5). Using data from all years, NPP increased significantly with increasing precipitation, including rainfall manipulations (Fig. 6, $r^2 = 0.75$, $p < 0.03$).

5. Soil carbon balance can be calculated as "net ecosystem production", the difference between heterotrophic soil respiration and net primary production. **Over three years, the heterotrophic component of soil respiration outweighed the net primary production term, signifying depletion in soil carbon**.

6. **Rainfall timing, rather than total amount, was the most important controller of net ecosystem production.** The soil carbon deficit increased strongly with temporal changes in rainfall patterns and increased slightly with augmentation of wet-season rainfall.

Figures

Figure 1. (a) Daily ambient precipitation data from September 2003 to August 2005, measured at Browns Valley (Station #84) by CIMIS (http://wwwcimis.water.ca.gov/cimis/welcome.jsp). Note: experimental water additions not shown here. (b) Volumetric soil water content (std errors, n =3) from 0-10 cm depth measured in irrigated (filled circles) and control (open circles) plots. (c) Soil temperature measured in water addition and control plots.

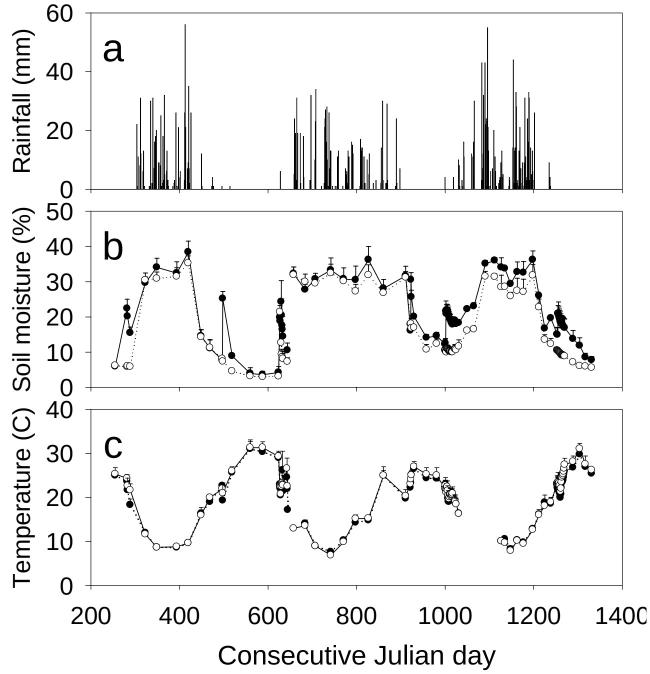


Figure 2. CO_2 fluxes from 6 wet-up events (means and std error, n = 3). (a) Fall wet-up, 9 October 2003, (b) Fall wet-up, 19 September 2004, (c) Fall wet-up, 27 September 2005, (d) Spring wet-up, 12 May 2004, (e) Spring wet-up, 12 July 2005, (f) Spring wet-up, 6 June 2006. Filled circles represent irrigated plots; unfilled circles signify control.

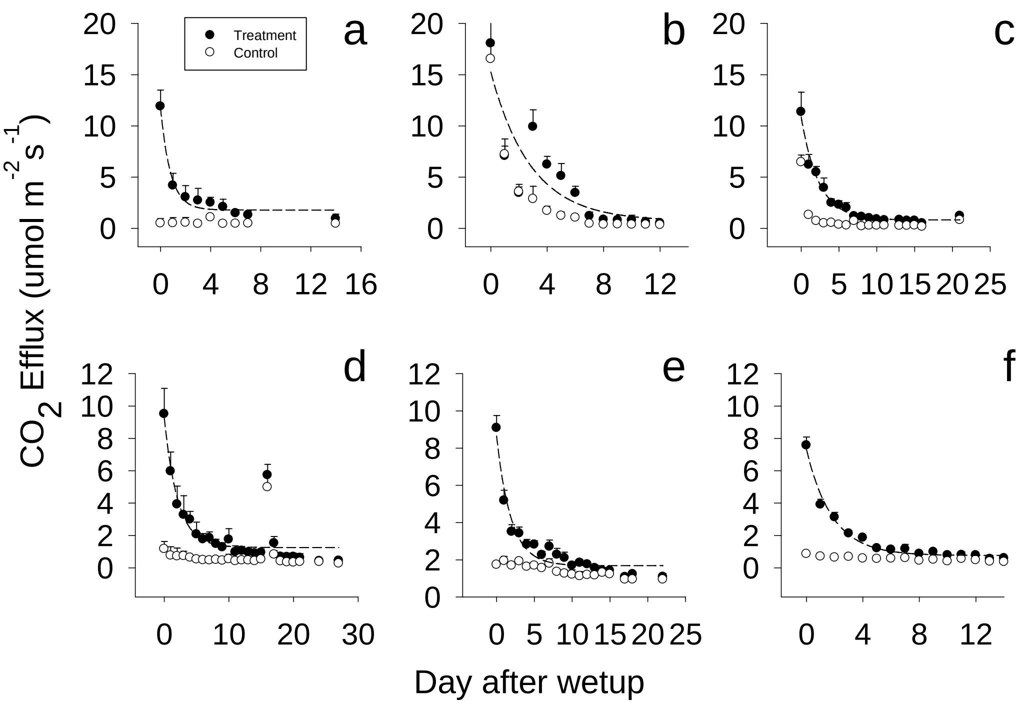


Figure 3. Mean monthly CO_2 fluxes (std errors) for three years. Dark bars represent irrigated plot values; light bars are control plot values.

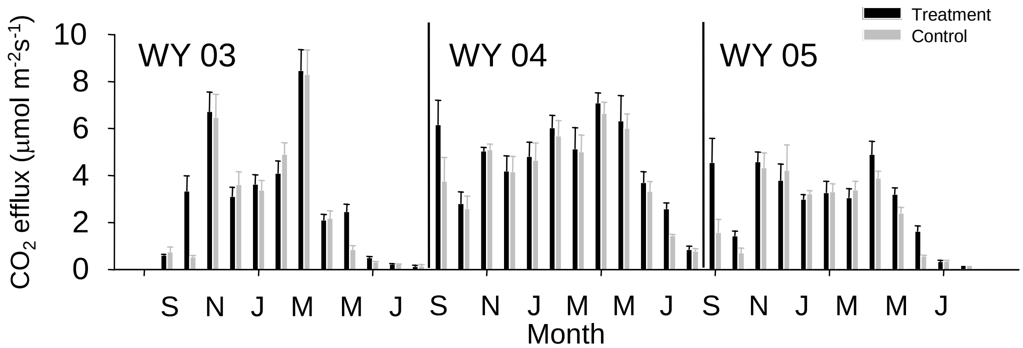


Figure 4. Soil respiration (means, std errors) and rainfall for three years. Dark bars represent treatment plot data, and light bars represent control plots. Circles connected by dashed lines indicate the amount of natural warm-season precipitation (defined as mm of May and June rainfall) for each water year. Total rainfall for each water year (in mm) is indicated by the number above the bars. Warm-season precipitation was greatest in WY 2004, coinciding with the highest C respired, although annual rainfall was greatest in WY 2005.

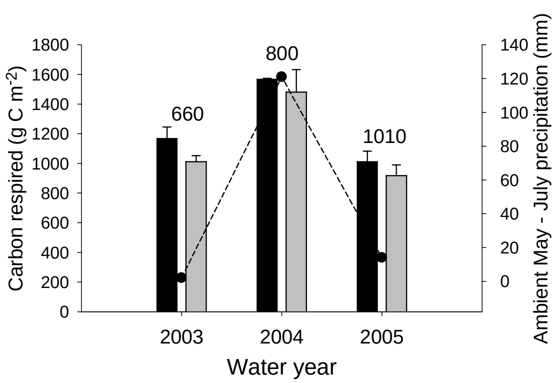


Figure 5. Net primary production for three water years. Dark part of bars represents belowground biomss; unshaded portion represents aboveground biomass.

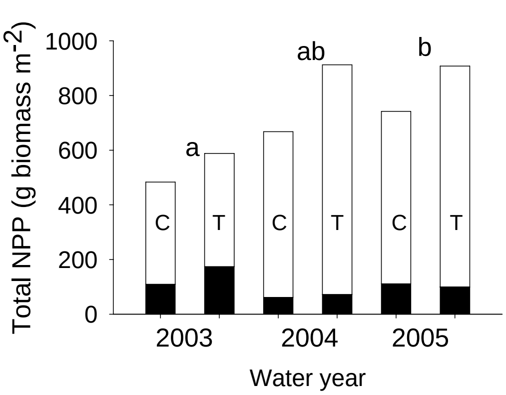


Figure 6. Annual NPP (g m^{-2} y^{-1}) in control and rainfall addition plots.

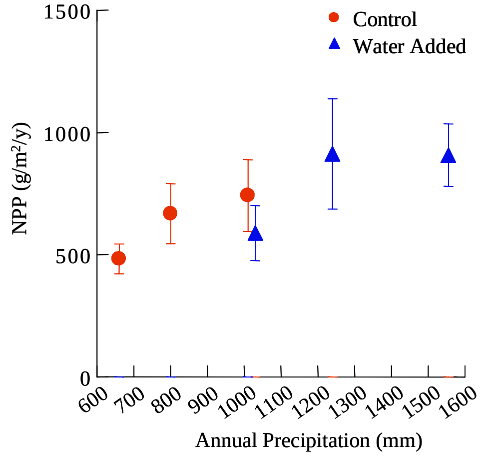


Table 1. Soil respiration by rainfall treatment over three water years

			C respired (g C m^{-2})		
Water year	Rainfall treatment	Rainfall (mm)	Early wet-up	Late wet-up	R_s (y^{-1})
2003-04	Control	660	13.2 (1.6)	26.4 (4.5)	1011 (42)
	Treatment†	1030	50.1 (7.4)	66.7 (3.3)	1170 (76)
2004-05	Control	800	46.0 (11.0)	37.8 (3.8)	1480 (152)
	Treatment	1240	74.9 (5.9)	63.5 (3.1)	1569 (6)
2005-06	Control	1010	14.1 (1.9)	9.4 (0.5)	918 (73)
	Treatment	1555	45.3 (1.1)	29.6 (3.3)	1012 (71)

Future Research Directions

Respiration and net primary productivity measurements will continue at the site for the foreseeable future. Depending on future funding, research plots will be augmented to create a dry-down treatment using rainfall exclusion shelters and all treatments will be combined with a simulated grazing manipulation.

Funding

This project was funded by the Kearney Foundation of Soil Science (Soil Carbon Mission) and the California Agricultural Experiment Station (7069-MS).

Relevant Publications

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Xu, L., D. D. Baldocchi, and J. Tang. 2004. How soil moisture, rain pulses, and growth alter the response of ecosystem respiration to temperature. *Global Biogeochemical Cycles* 18:doi:10.1029/2004GB002281.

Effects of prescribed fire on oak woodland soil landscapes

A.T. O'Geen*, A. Swarowsky. J. Deng, D.J. Lewis, R.A. Dahlgren, and K.W. Tate
*Dept. of Land, Air and Water Resources, University of California, Davis



Oak woodlands encompass 7.4 million acres in California and represent the interface between multiple land uses including agricultural, urban, and wildland (Griffin, 1977; Standiford and Howitt, 1993). Oak woodland watersheds play a major role in the drinking water supply system for the State, with almost all the State's surface water passing through these ecosystems as direct rainfall or snow melt from higher elevations. Two-thirds of all drinking water reservoirs in the State are located within grazed oak woodland/annual grassland ecosystems.

Oak woodlands are used extensively for cattle grazing, providing approximately 75% of the forage produced on California's rangelands. Grazing and prescribed fire are critical vegetation management tools allowing managers to maintain economically feasible agricultural enterprises, maintain open space, reduce fuel loads, improve habitat for certain wildlife species, and manage weed infestations. Grazing and prescribed fire are the most cost effective vegetation management tools available to most rangeland managers. Recently there has been a great deal of concern regarding the impacts of rangeland management on water quality. The transport of pathogens, nutrients, sediment, and dissolved organic carbon (DOC) from these landscapes to surface water bodies are of primary concern in this region. The objectives of this study were to document the effects of prescribed fire on physical and biogeochemical properties of soils in two settings inherent to oak woodlands, open grassland and under oak canopy.

Results

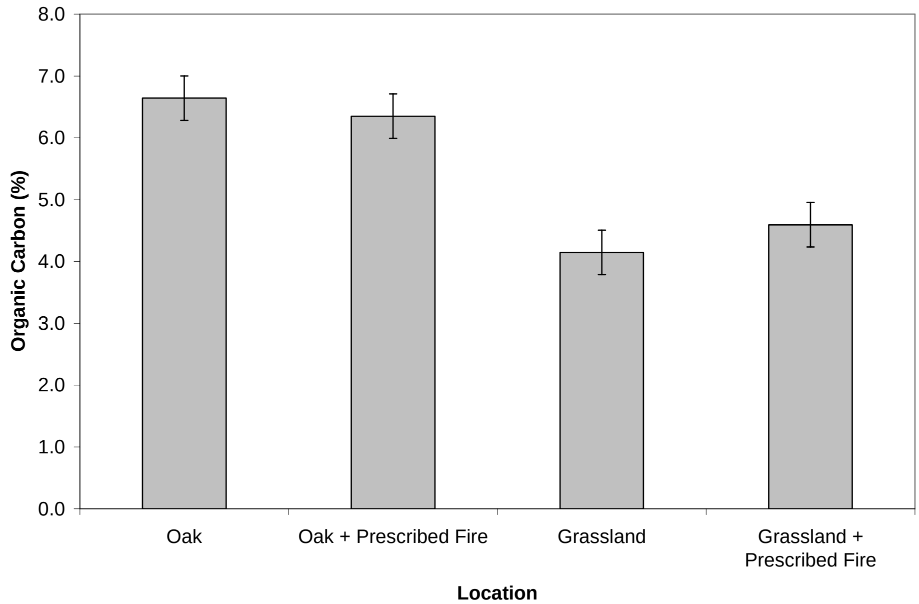

Figure 1. Effects of prescribed fire on soil organic carbon under oak canopy and open grass systems. No change in soil organic carbon was observed after fire in each system indicating that burn temperatures and fire intensity were low. Maintaining soil organic matter is important because it acts as a slow release fertilizer, maintains aggregate stability, increases water infiltration and helps prevent erosion.

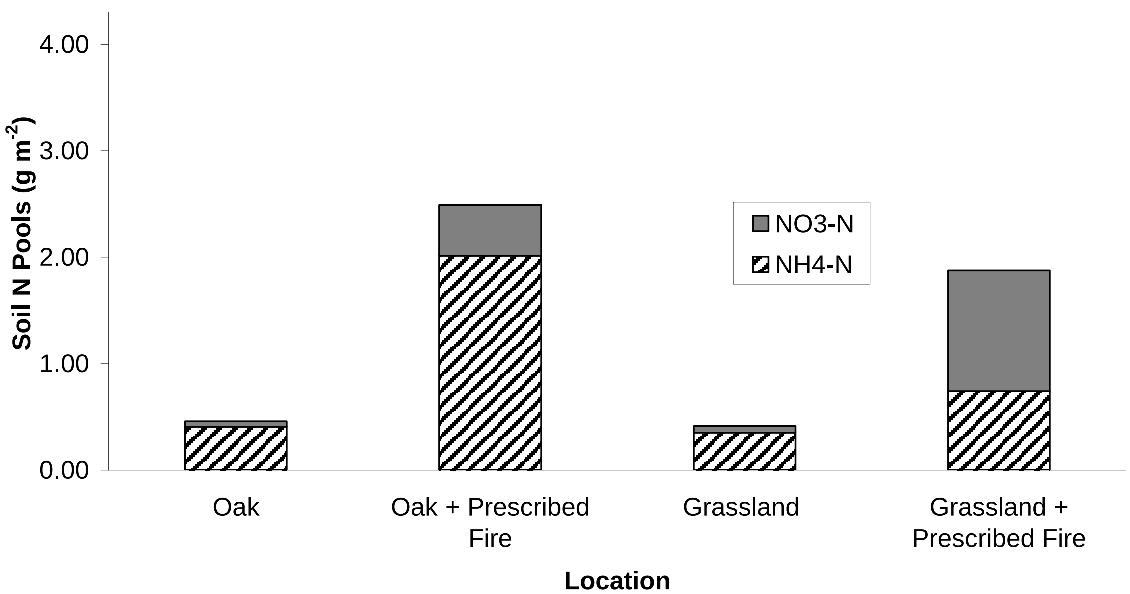

Figure 2. Effects of prescribed fire on soil nitrogen pools under oak and open grass systems. Since soil organic matter did not change significantly after burning we attribute increases in N after fire to the combustion of standing biomass and litter. Ammonium is the direct product of combustion. Nitrate arises through nitrification, a microbial transformation of ammonium.

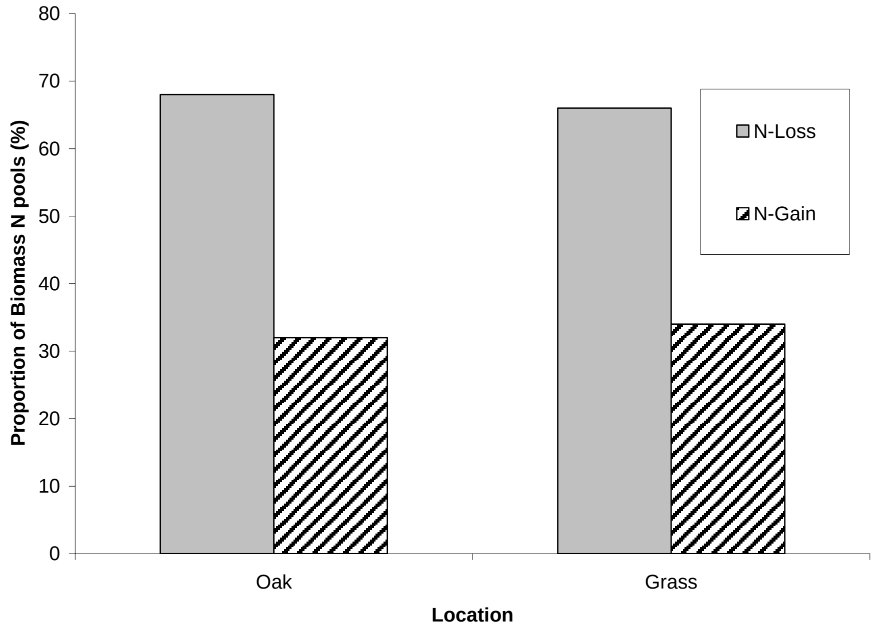

Figure 3. Effects of fire on the fate of Nitrogen in above ground biomass. Under oak, 32% of the N in biomass was supplied to the soil after burning, corresponding to a 20.2 kg ha^{-1} increase in soil N. The remaining 68% of biomass N was lost due to volatilization. In open grass 34% of the N in the above ground biomass was supplied to the soil after burning, corresponding to a 14.6 kg ha^{-1} increase. The remaining 66% of biomass N was lost through volatilization. The available N returned to the soil after fire was low, and less than the amount of N that is deposited as manure at stocking rates of 3 cows per hectare.

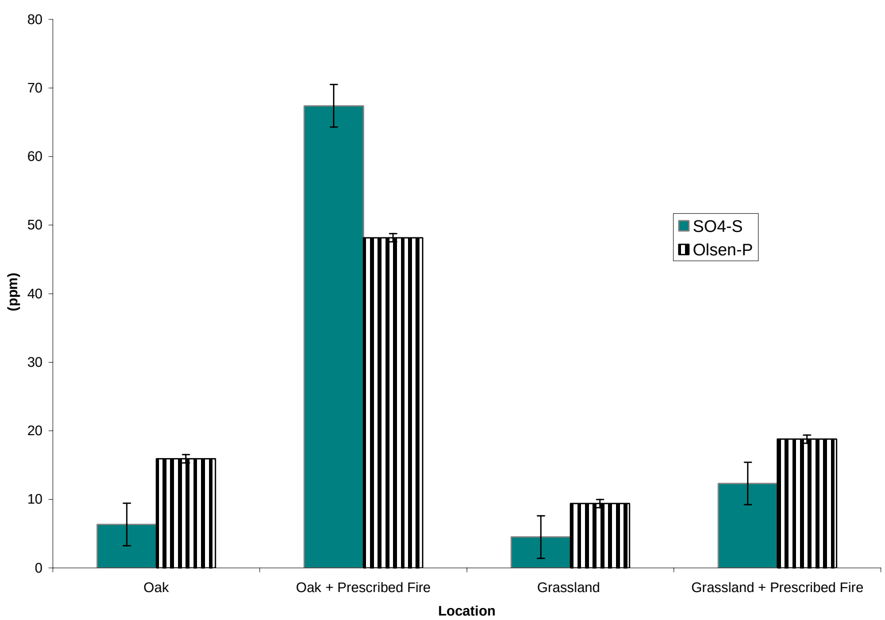

Figure 4. The effects of prescribed fire on sulfur and phosphorus concentration under oak and open grass systems. Burning converts the organic pool of soil P and S to sulfate and orthophosphate. Sulfur and phosphorus have higher volatilization

temperatures (>500°C) compared to nitrogen (200°C), thus the levels of S and P returned to the soil after burning were high particularly under oak. Post fire levels of P and S may be higher under oak because grazing is a selective process resulting in the removal of grasses, but not leaves and litter common to the surface of oak canopy soils.

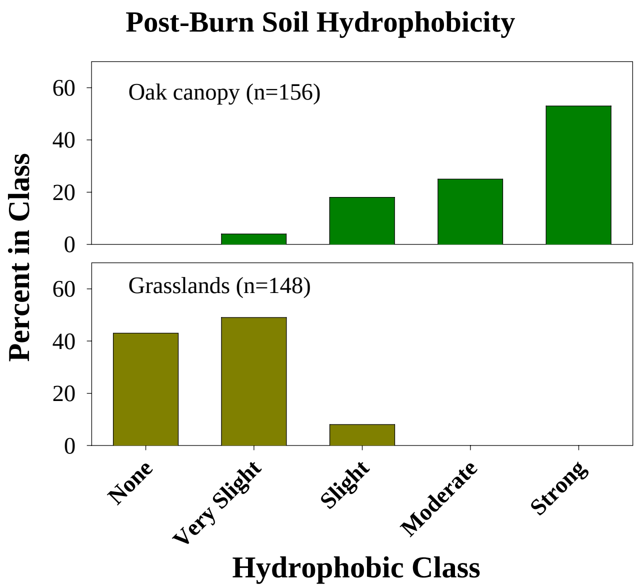

Figure 5. Effects of prescribed fire on water repellency of soils. Grassland soils displayed slight to no evidence of water repellency after fire. Soils under oak canopy displayed slight to strong degrees of water repellency. Water repellent conditions (hydrophobicity) under oaks are likely due to the release of waxes and resins from the combustion of oak leaves. Water repellency after fire is usually temporary.

Conclusions

Fire temperature plays a major role in the degree of nutrient and carbon loss from biomass. At the Sierra Foothill Research and Extension Center, soil organic carbon levels were not changed by fire. This is important because soil organic matter is critical to the health of rangeland soils. The combustion of above ground biomass increased the available N, P, and S. Especially under oak canopy soils where less biomass was removed by grazing.

The fire created water repellent conditions under oak canopies that may result in areas of accelerated runoff. Since the extent of these areas is limited to the oak canopy surface runoff may not have an effect on the entire watershed. Since very little N was supplied by the fire, this management practice should not affect stream water quality. P in streams should also be low, since P is a non-mobile nutrient. This may not be the case, however, if the erodibility of soils has increased. The 2004-2005 stream water quality data will be used to support this hypothesis. Timing of prescribed fire will likely be an important factor for water quality concerns.

Evaluating Techniques to Enhance Natural Blue Oak Regeneration

Doug McCreary and Bill Tietje, Natural Resources Specialists
Integrated Hardwood Range Management Program
University of California, Berkeley

Introduction

For nearly a century there has been concern that several native California species are not naturally regenerating adequately to sustain populations (Jepson 1910). One of the species identified as having poor regeneration is blue oak (*Quercus douglasii*) (Muick and Bartolome 1987). This species has a wide distribution, extending from the Siskiyous in the north to the Tehachapis in the south. The reasons for poor regeneration of blue oak vary by site and include competition from dense annual grasses, browsing by domestic livestock, and herbivory from a wide range of wildlife including grasshoppers, squirrels, gophers, voles, rabbits, and deer. All of these factors are aggravated by the fact that the rangelands where blue oak grows have a Mediterranean climate with an extended summer dry period. As a result, soil conditions can become exceedingly dry from late spring on, making it difficult for oaks to become established.

Research has demonstrated that the bottleneck for successful regeneration is from the seedling to the sapling stage (Swiecki et. al 1997). That is, each year sufficient numbers of small seedlings generally germinate and begin to grow in the understory, but very few of these survive long enough to become established saplings--that intermediate or “teen age” tree--prior to becoming mature. This lack of progression from seedlings to saplings has resulted in a bimodal size distribution in many blue oak stands, with considerable numbers of small seedlings and mature trees, but few saplings.

For the last 20 years, UC’s Integrated Hardwood Range Management Program (IHRMP) and others have worked on developing successful techniques for *artificially regenerating* oaks (McCreary 2001). Much of this research has been conducted at the Sierra Foothill Research and Extension Center (SFREC). It has demonstrated that establishing sapling-sized oaks is possible by the so-called artificial techniques, but it requires considerable management inputs and, as a result, can be costly. Therefore artificial regeneration is unlikely to be implemented over wide areas where blue oak regeneration is problematic.

An alternative oak regeneration strategy is to use naturally regenerating oak seedlings and take measures to promote their advancement to the sapling stage. However, this strategy has not yet been tested. This strategy could result in considerable savings because no effort or cost would be expended to collect acorns, or grow and plant seedlings. An additional advantage would be that only genetically adapted plant material would be used, alleviating concerns about using “offsite” planting stock. Because of these economic, ecologic, and low input (i.e., less work) advantages, the development of techniques to advance natural regeneration holds great promise for being widely adopted and implemented by landowners. Because ranchers own and manage most of the California oak woodland, they hold the key to sustainable management of the oak woodland resource and to actively enhancing oak recruitment.

To test the strategy of enhancing natural blue oak regeneration, a study was recently submitted to, and funded by, UC's Division of Agriculture and Natural Resources (ANR). One of the goals of this study is to promote collaboration among CE Natural Resources and Livestock Advisors, campus and area Specialists, and campus Faculty. This model has been used previously by the IHRMP in a statewide project evaluating the sprouting of blue oak and generated useful information regarding the management of mature blue oak stands (McCreary et. al 1991; McCreary et. al 2002). Because oak regeneration is a statewide concern and the different cooperating advisors all work in foothill areas that have abundant oak woodlands, this is a project that allows such collaboration. It also has the potential to yield meaningful practical results because, if successful, promoting successful natural regeneration could play a significant role in efforts to help ensure that our blue oak woodlands successfully regenerate and are sustained.

Methods

Eight sites broadly representing the range of blue oak will be used in this study. Sites will range from Tehama County in the north to Santa Barbara County in the south and will include sites both within the coast range and the western foothills of the Sierra Nevada. At each site, 144 naturally occurring blue oak seedlings between 3 and 12 inches tall will be identified. We will select the seedlings such that half are under the canopy of the trees on the site and half are outside the drip line in the open.

The 72 seedlings per shade treatment will be arranged in 18 groups of 4 seedlings each. Within each group seedlings will be no closer than 4 feet apart and no further than 20 feet apart. One member of each group will be covered with a treeshelter in spring, 2007. A second seedling in each group will have the ground vegetation within 2 feet of the seedling eliminated by spraying with contact herbicide (roundup). The third seedling of each group will be covered with a treeshelter and have the vegetation removed around it. The fourth seedling will be a control with no protection or weed control.

Prior to the installation of the treatments, each seedling will be measured and the height will be recorded. Four similar sized seedlings in the vicinity of those being used in the study will be harvested at each site and taken to Berkeley to assess their age by counting tree rings using a dissecting scope. In the fall of the subsequent three years, each seedling will be assessed for survival, height and basal diameter. If any seedlings die, we will try to identify the cause of death (e.g., gopher damage, aboveground herbivory, drought). Standard meteorological and edaphic measurements, as well as management history, will also be collected for each site and will be used to determine if any site variables are correlated with seedling response.

Statistical Analysis

The seedling data will be analyzed as a nested randomized block experiment with sites as the main plots, shade treatments as the sub plots, and combinations of treeshelters and weed control as the sub-sub plots, with 18 blocks per site and shade treatment. For each response variable (survival, height and diameter growth), we will determine if there are significant site, shade and/or treatment effects. We will also test to determine if there are significant interactions between the different variables. We anticipate the greatest treatment effects to result from the treeshelters, but are not sure if the benefits of treeshelters will be consistent over sites (no interactions) and whether the effects of weed control will be additive (weed control will enhance the effects of the treeshelters), or operate independently. It is also likely the effects of the treeshelters will be confounded by shade treatments; i.e., because the shelters alone reduce solar radiation by approximately 50 %, it is likely that seedlings in shelters will not do as well in the beneath-the-canopy treatment. We will also use regression analysis to determine the correlation of site variables with seedling performance.

Conclusions

It is hoped that results from this study will yield meaningful information relating to approaches that can be used to enhance the natural regeneration of blue oak If successful techniques are identified, they could help promote increased blue oak regeneration and thereby enhance oak conservation efforts throughout the state.

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Landscape-scale Relationships between Oak Recruitment and Livestock Management

W. Stanley Harpole, Katharine Nash Suding, Rebecca Aicher (University of California Irvine), and Mitchel McClaran (University of Arizona)

The long-term establishment and success of California oaks is a major conservation concern. Mature trees are abundant but suffer losses due to land use and disease. Seedlings are common but saplings are frequently absent. As a result, there is concern that recruitment from seedling to mature tree will not be sufficient to replace trees when they die. Livestock and non-native annual grasses are implicated as main factors limiting recruitment from seedlings to mature trees. Grazing impacts may play a positive or negative role in oak recruitment dependent on the timing of grazing. For example, grazing in winter, during the herbaceous growing season might improve recruitment by reducing competitive effects from herbaceous species. In contrast, grazing in summer, during the herbaceous dormant season may limit recruitment because livestock may prefer the green foliage provided by seedlings.

We are using a combination of field surveys and field and greenhouse experiments to test how the timing of grazing interacts with herbaceous vegetation to affect blue oak (*Quercus douglasii*) recruitment. We have tagged over 300 seedlings and nearly 200 saplings in three pastures that are either ungrazed, or grazed during the growing season or during the dormant season. Our preliminary survey results suggest that oak seedlings are more frequent in grazed pastures, without regard to season of grazing. Sapling density was relatively constant across all three pastures. There was some evidence that high vegetation cover in pastures grazed in the growing-season may benefit oak seedlings, perhaps because cattle have a harder time finding them or had other food choices. However, in ungrazed and dormant-season grazed pastures, oak seedlings were less frequent in areas of high vegetation cover, perhaps indicating competition or herbivory was more intense in these areas. While sapling numbers were similar across all pasture types, and not predicted by vegetation or bare ground, we cannot say whether seedling survival and transition rates (to sapling stage) are consistent across pastures. We are following marked seedlings and saplings to begin to estimate survival and transition probabilities.

Several factors may be playing a role in oak population dynamics in these pastures. For instance, it is difficult to tell whether cattle are directly affecting oaks via herbivory or whether they are indirectly affecting oaks via changing the herbaceous community, residual dry matter, or soil conditions. We are in the process of conducting greenhouse and field experiments to separate the effects of grazing and competition on oak performance. This will allow us to tease apart the different factors that may be playing a role in the recruitment patterns we have measured here. This project is funded by the University of California's Integrated Hardwood Range Management Program.

Mechanistic Foundations of State and Transition Models: Linking Application and Theory

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Rangeland systems can exhibit complex dynamics in response to disturbance such as grazing. Large shifts in vegetation states can occur with little warning and once the shifts occur they may be difficult to reverse. We are testing how grazing intensity may drive transitions between rangeland states. We are focusing on three rangeland states of management concern: 1) perennial native grasslands dominated by species such as Needlegrass (*Nassella pulchra*), 2) annual exotic grassland state dominated by acceptable forage species such as annual rye (*Lolium multiflorum*) and wild oats (*Avena fatua*), and 3) annual exotic grassland dominated by noxious weeds such as Medusahead (*Taeniatherum caput-medusae*). These vegetation types are thought to potentially form alternative stable states: each state, once it is established becomes resistant to change (Figure 1 depicts a conceptual, two-state system). In addition, we are investigating how vegetation change initiated by grazing intensity may promote positive plant-soil feedbacks involving soil microbes, which would reinforce such vegetation states in rangelands. Exotic and native California grasses, have been shown to "culture" different communities of soil microorganisms that cause each plant species to grow better in its own soil and worse in the other's soil. We will also use mathematical models in conjunction with our experimental results to further link alternative state theory to rangeland applications.

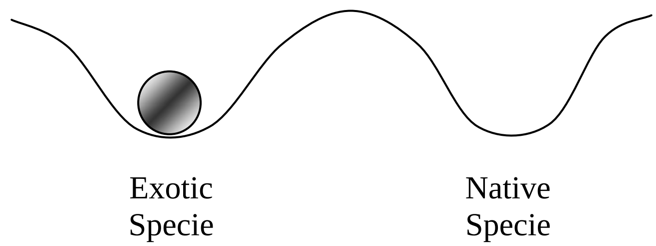

Figure 1. Exotic and native species may form *Alternative Stable States* which are relatively resistant to change, analogous to a marble in a

We use the following four tests of alternative states:
1. **Persistent states** after perturbation. If the perturbation that drove a change in state is removed, the system does not revert to its original state. This is the basic premise behind state-and-transition models: overgrazed rangelands often do not recover when grazing pressure is reduced.
2. **Divergence** of the system from different initial conditions. Starting the system with different species composition should lead to alternative final states. A corollary is that these states are not invasible by the other state once they are established.
3. The system will exhibit **hysteresis**. An ecosystem shift in response to a small environmental change will not be reversible by an equally small environmental change in the other direction. Such hysteretic responses have obvious importance for managing or restoring ecosystems.
4. The presence of **positive feedbacks**. Positive feedbacks amplify small deviations and either push a state into a different region of attraction or allow it to return to its original state. Negative feedbacks then stabilize the system locally, establishing stable states.

Our experiment will consist of sixteen replicate fenced enclosures established in two existing grazed pastures: eight in a pasture dominated by Medusahead (Lower Scott 14) and eight in a pasture dominated by acceptable forage annuals such as Oats (Scott 5 Dry). We will establish 4 plots each of the three vegetation states: 1) native perennial grasses *Nassella pulchra*, *Elymus glaucus*, and *Melica californica*; 2) "acceptable" exotic annual *Avena fatua* and *Lolium multiflorum* (oat and rye); and 3) noxious annual grass *Taeniatherum caput-medusae*. We also establixhed four control plots that have not been disked. Each plot will be divided into 12 subplots which will receive one of the six grazing level treatments. Grazing levels will be achieved by strategically moving temporary electrified mesh panels down the length of the plot. Cattle will be used to achieve moderate grazing intensities and subsequent mowing will be used to further reduce Residual Dry Matter (RDM; the old plant matter left standing at the start of the growing season) to target levels. Grazing plus mowing intensities will range from ungrazed (expected RDM 1500-1800 lbs/acre) to heavily grazed (RDM ~15% of ungrazed, 200-300 lbs/acre, based on previous estimates of an intensely grazed rangeland property bordering SFREC).

Specific results that would support hypotheses

1. Persistent States. To test our first hypothesis, we will concentrate on grazing manipulations in the control plots. We will add the seeds of our three focal groups in year 3: noxious annuals, acceptable forage annuals, and native perennial grasses and measure invasion success. This will allow us to test whether the original dominant of the pastures (Medusahead or Oat species) will be relatively resistant to the invasion of the other groups, and able to persist across a range of grazing intensities.

2. Divergence. We will follow species composition in the planted plots across a gradient of grazing intensities. In year 3, we will invade each vegetation type with the other species groups. We will follow invasion success in these manipulations to test whether alternative rangeland states can exist dependent on initial conditions. At each level of grazing intensity, we will test whether: 1) the species group was able to establish when it was originally planted in year 1; and 2) the other species groups were unable to invade it (i.e., not have a positive population growth rate) when added in year 3. If both these criteria are met, we will consider the species group a stable state at that level of grazing intensity. If two species groups meet the criteria at the same level of grazing, we will consider this support for the existence of multiple stable states.

3. Hysteresis. Here, as in Hypothesis 1, we will concentrate on grazing manipulations in the control plots that will be conducted in two types of pastures: dominated by Medusahead and dominated by oat and rye species. We will compare invasion success between the two pasture types. Hysteresis would be indicated if grazing intensity where oats and rye can successfully invade the Medusahead pasture is different than the grazing intensity where Medusahead can successfully invade the oat and rye pasture.

4. Plant-soil Positive Feedback. We will conduct a soil culturing experiment to determine the effects of the soil microbial community on plant growth and survival ("soil culturing"). To describe soil microbial communities, in year 3 we will collect rhizosphere soil and measure fungal and bacterial community composition across a range of grazing intensities and dominance states. We will use the collected rhizosphere soils as inoculums in a greenhouse feedback experiment that will be conducted at UC Irvine.

The experiment is currently in its first year and is funded by the United States Department of Agriculture. With substantial help and support by SFREC, this past summer (2006), we herbicided, disked and solarized experimental plots in the two pastures (one dominated by Medusahead and the other by oats and rye). This winter (2007) we planted nearly 18,000 native grass plugs and sowed seeds of both exotic annual grass types (oats and rye, and Medusahead). We will continue weeding as needed and allow the planted communities to establish during the remainder of this growing season and the next. In year three we will begin the grazing and seed invasion treatments.

Recent Annual Rangeland Buffer and RDM Study Results

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Jim Bartolome, University of California, Berkeley

Objectives

The objective of this project was to assess the efficacy of annual grassland buffers to attenuate *E. coli* and *C. parvum* released from cattle fecal material deposits and entrained in surface runoff under natural rainfall-runoff and hillslope conditions. We examined the efficacy of 0.1, 1.1, and 2.1 m buffers at 3 land slopes (%) and 4 vegetation levels (kg/ha) across 27 rainfall-runoff events during 2 rainfall seasons.

Experimental Approach

The experimental unit was a 2.0 m wide by 3.0 m long annual grassland runoff plot designed to collect surface runoff during natural rainfall-runoff events. Three blocks of 16 plots (48 total plots) were established at land slopes of approximately 5, 20, and 35%, respectively. October residual dry vegetation matter (RDM) treatments of 225, 560, and 900 kg/ha were implemented by hand cutting and removal of vegetation. A non-cut control RDM treatment was implemented, with levels averaging 4,500 kg/ha. Vegetative buffer width treatments (0.1 m, 1.1 m, and 2.1 m) were implemented by placement of cattle fecal material containing known loads of *E. coli* and *C. parvum* up-slope of the runoff collector. A no fecal material application treatment was included as a baseline. All surface runoff was collected and total *E. coli* and *C. parvum* discharge determined for each plot during the study period (3/03 to 3/04) (Fig. 1). Treatment effect on total *E. coli* and *C. parvum* pollutant discharge was determined via linear mixed effects analysis to adjust for repeated measures on each plot.

Key Results – Focus on *E. coli*

A. Annual grassland buffers were very efficient at attenuating *E. coli* and *C. parvum*. *E. coli* attenuation for 1.1 to 2.1 m buffer widths compared to 0.1 m buffer width ranged from an additional 2.22 to 0.31 $\log_{10}$ reduction (orders of magnitude), respectively, as total plot runoff increased from 15 to 65 L (Fig. 2 and 3).
B. As runoff volume increased, buffer efficiency decreased. There was a significant interaction between buffer width and total runoff per plot which indicates that the effect of buffer width on *E. coli* discharge was in part dependent upon total runoff (Fig. 3).
C. *E. coli* discharge was significantly related to RDM levels. *E. coli* discharge decreased as RDM increased from 225 to 900 kg/ha, but that *E. coli* discharge increased as RDM then increased to 4500 kg/ha (Fig. 4). *C. parvum* was not correlated to RDM.
D. As slope increased, so did *E. coli* and *C. parvum* transport (Fig. 2).
E. Background *E. coli* levels (no cow pats) were not zero. *E. coli* discharge from no feces control plots ranged from 4.15 to 2.44 $\log_{10}$ lower than 0.1 m buffer plots as total plot runoff increased from 15 to 65 L (Fig 2 and 3).

Fig. 1. Cumulative rainfall (cm), storm runoff collection timing, and fecal material application dates during the portions of the 2002 rainfall season (3/12/03 through 5/2/03) and 2003 rainfall season (12/14/03 through 3/2/04) included in the study period.

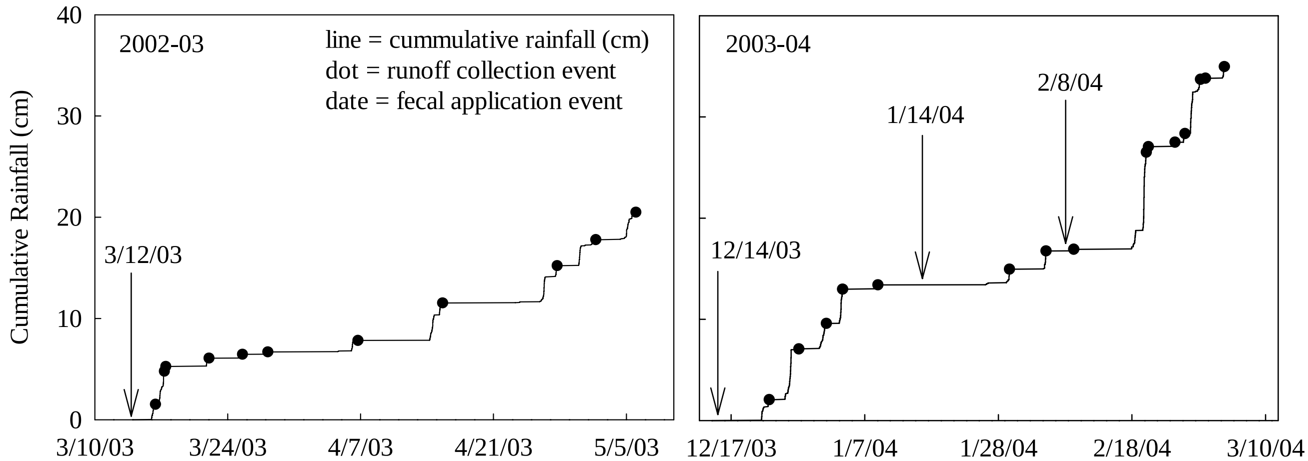


Fig 2. Mean total *E. coli* (cfu) discharged from 2.0 m wide by 3.0 m long annual grassland runoff plots over 27 storms following application of a total of 41.5 x 10^9 *E. coli* (cfu) in cattle fecal material between 3/03 and 3/04. a) mean discharge for buffer treatments of 0.1 m buffer, 1.1 m buffer, 2.1 buffer, and a no fecal application negative control. b) mean discharge for residual dry vegetation matter in October treatments of 225, 560, 900, and 4500 kg/ha). c) mean discharge for land slope treatments of 5, 20, and 35%. Error bars report 1 standard error of the mean.

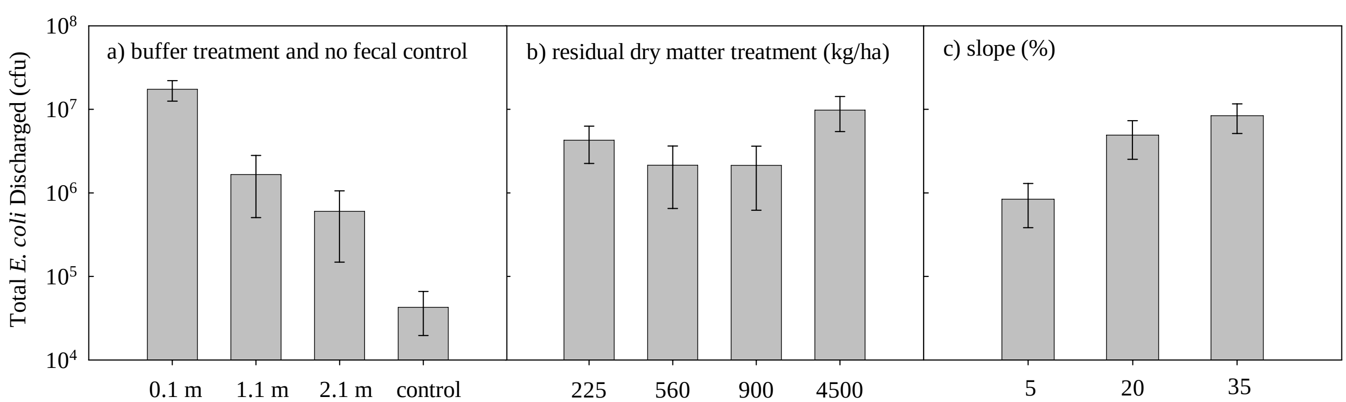


Fig. 3. Relationship of total *E. coli* discharge (cfu) and $\log_{10}$ reduction in discharge due to buffer width and total runoff for storm series observed during portions of the 2002-03 and 2003-04 rainfall season contained in the study period.

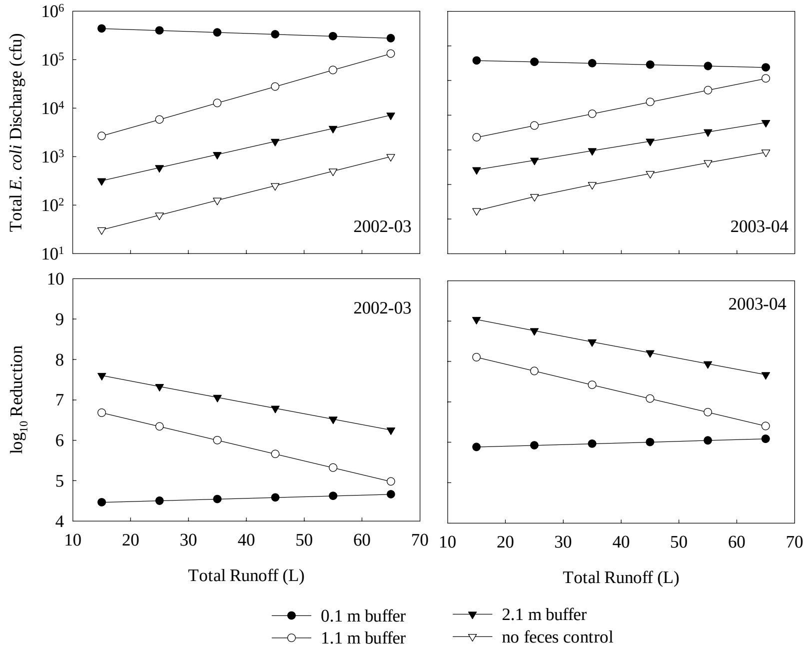
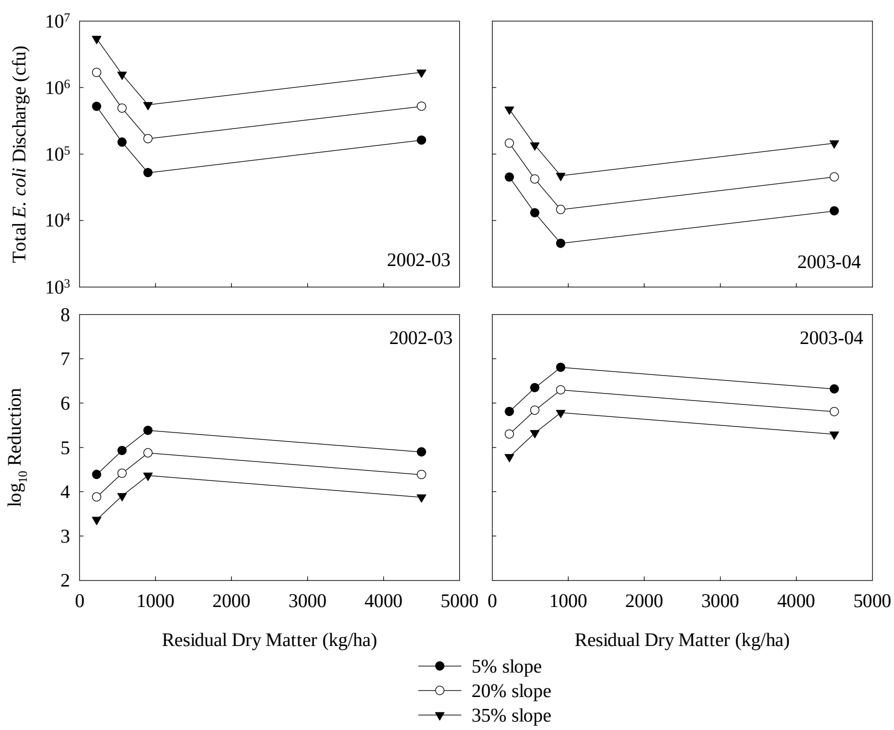


Fig. 4. Relationship of total *E. coli* discharge (cfu) and $\log_{10}$ reduction in discharge due to residual dry vegetation matter and land slope for storm series observed during portions of the 2002-03 and 2003-04 rainfall season contained in the study period.



Future Research and Demonstration

Over the next 3 years we will be working at SFREC to test the effectiveness of annual rangeland filter strip management effectiveness for attenuating additional pathogens (e.g., *C. parvum*, pathogenic *E. coli*) and organic carbon. We will establish pasture scale demonstrations of these integrated management measure implementation strategies.

Funding

Past research was funded by International Life Science Institute, and Proposition 50 Drinking Water Quality Program administered by CALFED-SWRCB-Central Valley RWQCB.

Publications

Tate, K.W., E.R. Atwill, J.W. Bartolome, and G.A. Nader. 2006. Significant *E. coli* Attenuation by Vegetative Buffers on Annual Grasslands. J. Environmental Quality. 35:795-805.

Atwill, E.R., K.W. Tate, M. Das Gracas C. Pereira, J.W. Bartolome, G.A. Nader. 2005. Efficacy of Natural Grass Buffers for Removal of *Cryptosporidium parvum* in Rangeland Runoff. J. Food Protection. 69:177-184.

Recent Irrigated Pasture Water Quality Study Results

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Objectives

1. Determine discharge water quality from typical flood irrigated pasture in Sierra Nevada foothills.
2. Identify grazing and irrigation management practices associated with elevated and reduced pollutant discharge from these flood irrigated pastures.
3. Examine the efficiency of vegetative filter strips/buffers and wetlands to attenuate pollutants in discharge from these flood irrigated pastures.

Pollutants

E. coli, fecal coliforms, suspended solids (sediment and organic), turbidity, dissolved organic carbon (DOC), nitrogen, and phosphorus.

Experimental Approach

1. Runoff plot-based experiments:
   - 9, 240 m^2 plots with 0, 8, and 16 m filter strip treatments designed to test non-grazed or cut filter strip effectiveness below rotationally grazed, irrigated plots.
   - 10, 8 m filter strip plots designed to test the effect of vegetation cutting on nitrogen attenuation efficiency of buffers.
2. Pasture scale study of discharge water quality under rotational grazing and 3 levels of irrigation application.
   - 3 irrigated pastures (5 to 10 acres) containing a total of 10 irrigation sets.
   - Field scale application of rotational grazing and irrigation management.
3. Field study of reduction in pollutant load in pasture tail water passing through 2 wetlands.
   - 2 wetlands (~0.5 acres) receiving runoff from grazed irrigated pasture.

Objective 1 – Key Results

A. *E. coli* concentrations are substantially above currently recommended/accepted water quality standards of 126 cfu/100 mL for monthly 30 day average of 5 readings, or 235 cfu/100mL for a single grab sample. This warrants investigation of the actual level of pathogens in discharge, and evaluation of management measures to reduce discharge levels. *E. coli* as reported here is simply an indicator (Table 1).

B. Dissolved organic carbon is at levels which raise concern, and warrant investigation of the composition of DOC from these pastures and the likelihood of forming disinfection (chlorination) by-products such as trialomethanes during drinking water treatment, and evaluation of management measures to reduce discharge levels. DOC as reported here is simply an indicator (Table 1).

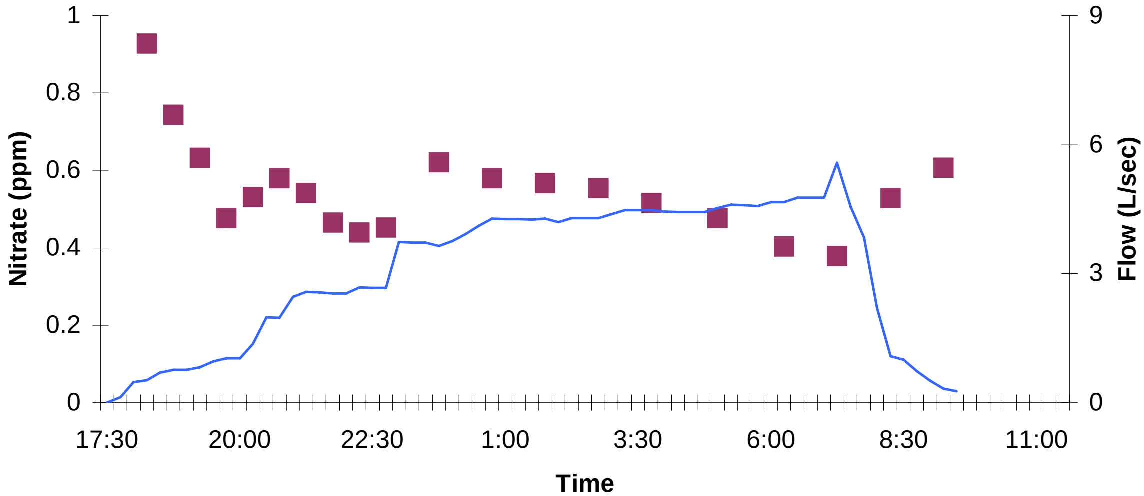
C. On average, 85% of total suspended solids in discharge is organic and 15% is mineral (sediment). This indicates that erosion is not the primary source of TSS from well vegetated pastures, rather particulate organic matter.

D. Significant variation due to flushing and dilution of pollutions occurs during an irrigation event, adding uncertainty to the interpretation of individual grab samples (Fig. 1).

Table 1. Concentration of key water quality parameters from irrigated pastures at SFREC – summer 2004. Calculated from 500 to 1000 discharge water samples.

Constituent	Minimum	Mean	Maximum
E. coli (cfu/100mL)	0	10,574	538,700
Nitrate (ppm)	<0.05	0.37	2.05
Ammonium (ppm)	<0.05	0.11	0.2
Total N (ppm)	0.31	1.73	4.96
Phosphate (ppm)	<0.025	0.068	0.137
Total P (ppm)	<0.025	0.139	0.353
Dissolved Organic Carbon (ppm)	0.33	9.51	22.21
Total Suspended Solids (mg/L)	8	47.5	216

Fig. 1. Nitrate concentrations (square marks) and discharge rate (line) during an irrigation – runoff event from flood irrigated pasture.



Objective 2 – Key Results

A. Rotating cattle out of the pasture prior to irrigation (e.g., 2, 5, 7 days) is an effective management practice to reduce pollutants in discharge. Concentration and load of all constituents in discharge decreased as the time (days) of rest from grazing prior to irrigation increased (Fig. 2).
B. Reducing the runoff rate and thus transport capacity of discharge is an effective management practice to reduce pollutants in discharge. Concentration and load of all constituents in discharge decreased as the irrigation water application rate and resulting discharge rate was reduced across the range of 0.7 to 0.2 acreft/ac/event (Fig. 2).
C. Implementing appropriate stocking rate and stock density is an effective management practice to reduce pollutants in discharge. Concentration and load of all constituents in discharge decreased as cattle density and fresh fecal load increased (Fig. 3).
D. Much water quality improvement can be made with modification of grazing, irrigation, and fertilizer management on pastures. It is also likely that these modifications will have beneficial production and economic by-products. Much of this information is available from past research, trials, etc.

Fig. 2. Pollutant concentrations during 4 hour irrigation – runoff trials under conditions of rest from grazing prior to irrigation and implementation of vegetative filter strips (0m – control, 8m – 1:3 buffer:pasture area ratio, 16 m – 1:6 buffer:pasture ratio.

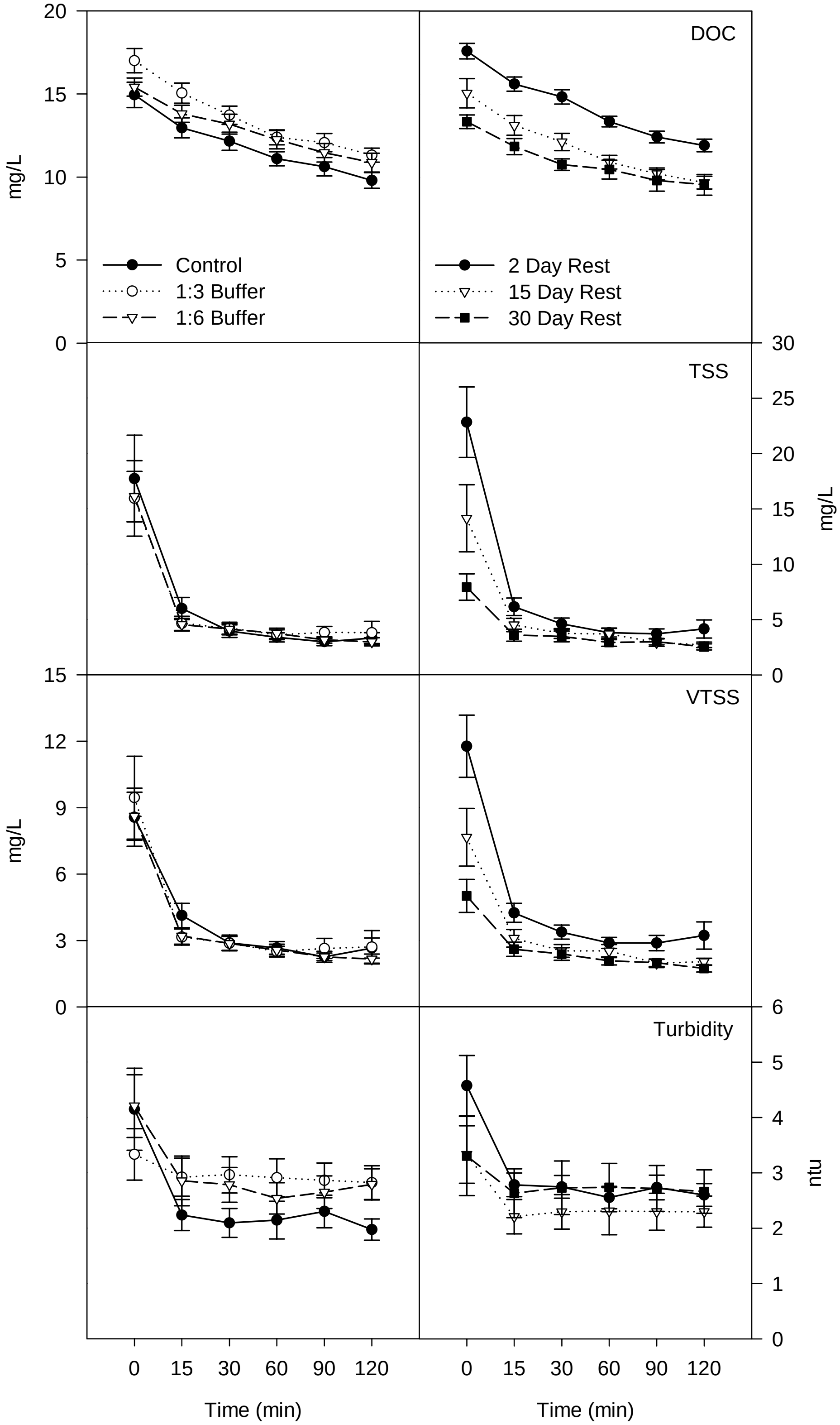
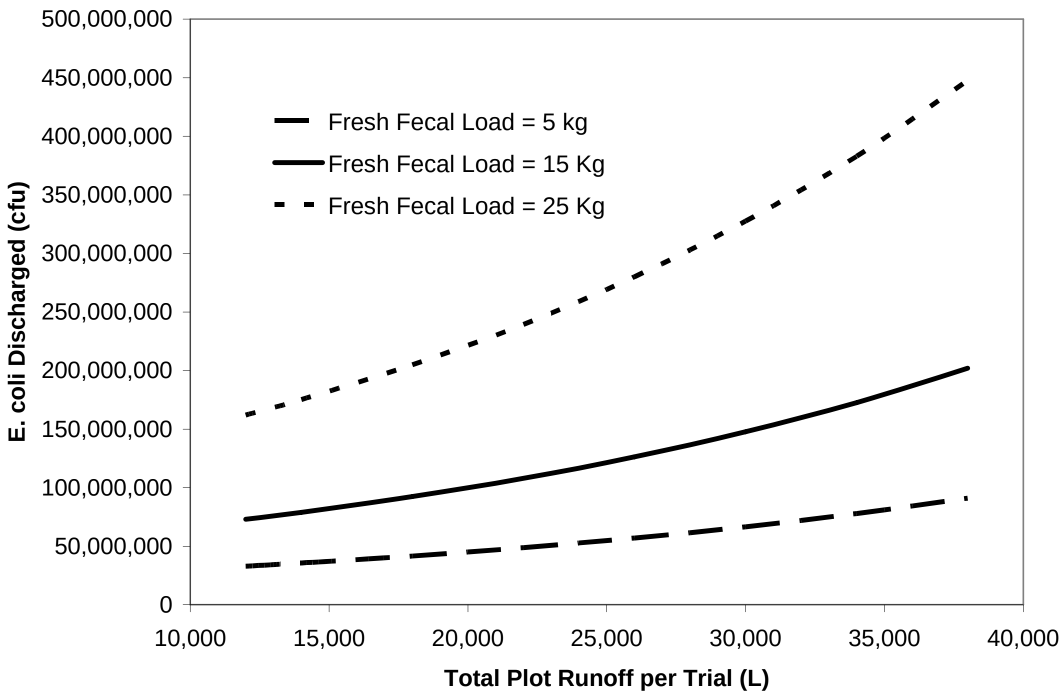


Fig. 3. Example relationship between *E. coli* concentration in irrigated pasture discharge, discharge rate, and fresh cattle fecal load at time of irrigation, with 2 days rest before irrigation.



Objective 3 – Key Results

A. The effectiveness of vegetative buffer strips to filter pollutants in irrigated pasture discharge is dependent upon discharge rate. At high irrigation application rates (~0.5 acreft/ac/event) we found non-grazed or cut filter strips (8 to 16 m wide) to be moderately effective for reducing N and P in runoff. We did not observe a reduction in *E. coli* concentration or load under these runoff rates. We observed an increase in DOC discharge due to unmanaged buffers under these runoff rates (Fig. 2). Further study is underway on a new set of 18 irrigation plots which allow enhanced study of the effect of irrigation application rate and runoff rate on vegetative filter strip efficiency in this setting.

B. We have found that regular (monthly) cutting and removal of vegetation in filter strips significantly improved the efficiency of buffers for reducing N levels in discharge (Fig. 4). Maintaining uptake by plants, removal of N trapped in plants before it is cycled and released keeps buffers as sinks rather than sources for N. Very likely this management can resolve the problem of buffers becoming sources for DOC (Fig. 2).

C. Wetlands filtered from 40 to 90% of all pollutants (nutrients, sediment, bacteria) contributed to them with filtration efficiency decreasing as tailwater discharge rate increased and hydrologic residence time decreased (Fig. 5). We also found that *E. coli* levels in tailwater increased as irrigation water application rate increased, stocking rate increased, and days rest between grazing and irrigation decreased. *E. coli* concentrations above the wetland (pasture runoff) ranged from 420 to 157,800 cfu/100ml with a median concentration of 5,400 cfu/100ml. E. coli concentrations in pasture runoff above the wetland were never below the 235 cfu/100 ml standard recommended by US EPA for any of the samples (n=182) collected during any of the 14 irrigation events. Overall, *E. coli* concentrations below the wetland (filtered pasture runoff) were significantly lower than pasture runoff. Wetland effluent concentrations ranged from 10 to 74,600 cfu/100ml with a median value of 1,283 cfu/100ml.

Fig. 4. Nitrogen tracer levels in pasture discharge for cut (to ~3 inch ht) and uncut filter strips. Cutting effect began to emerge on day 40 following cutting as plant growth accelerated.

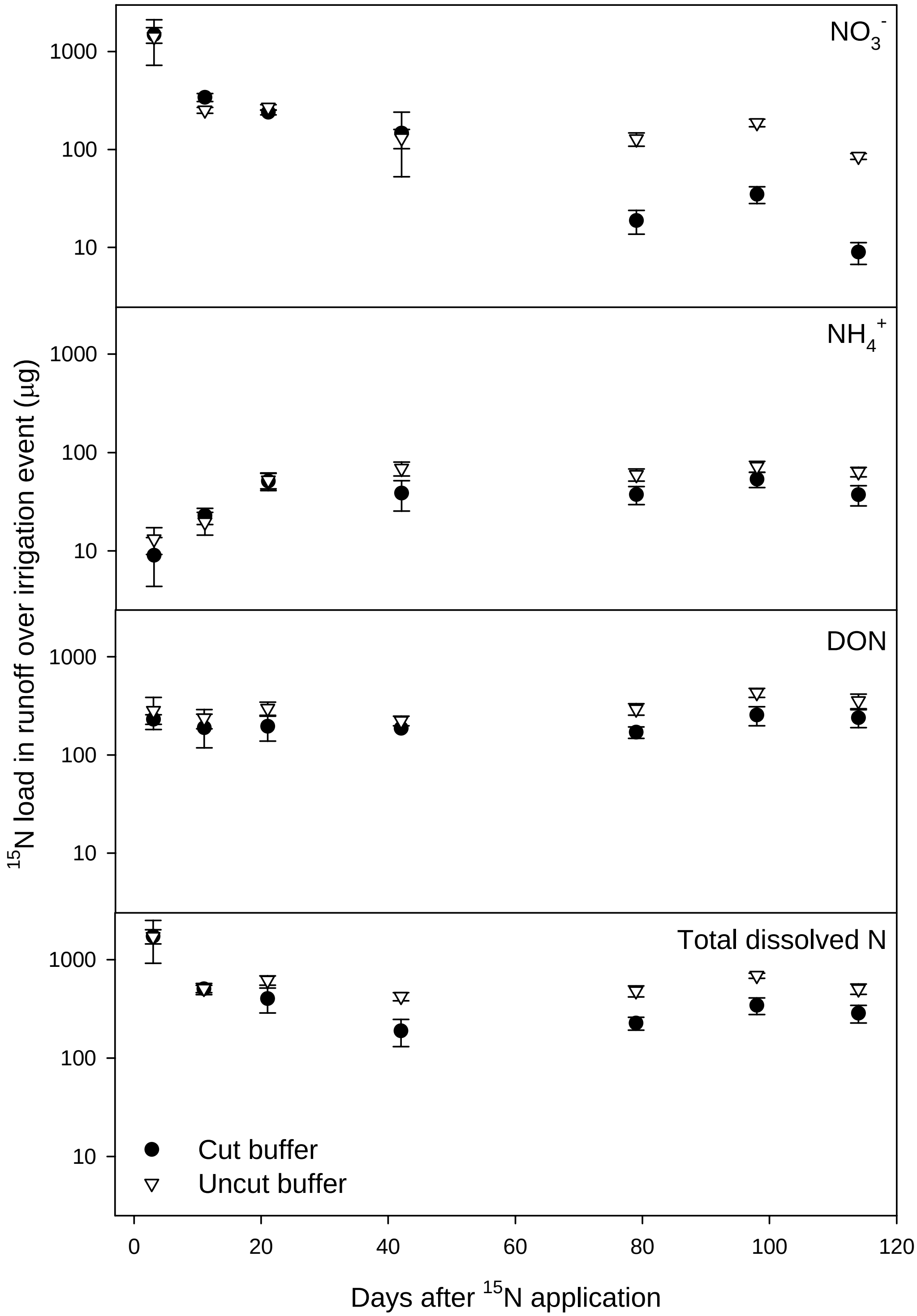
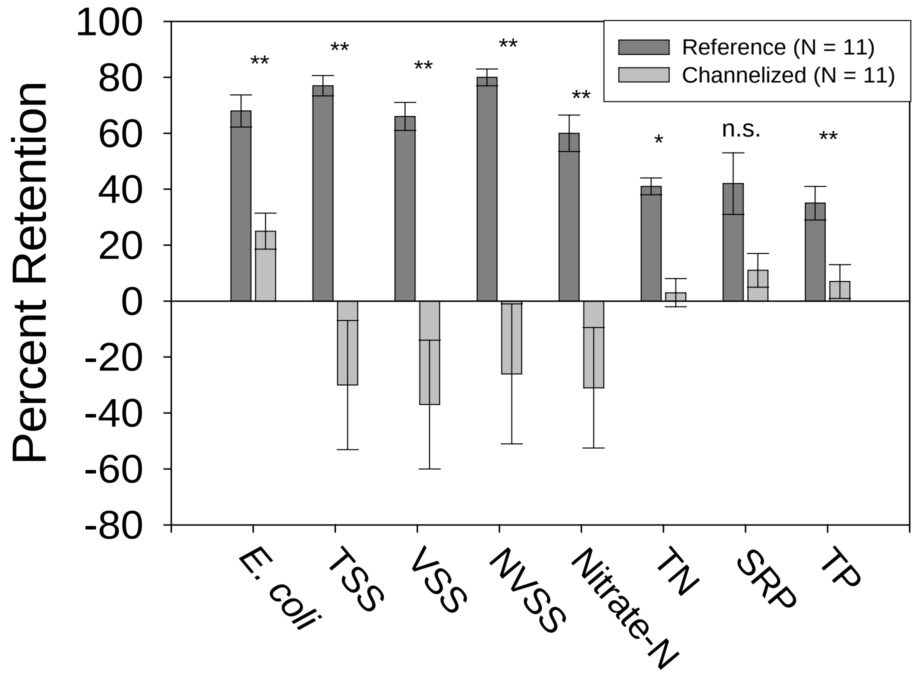


Fig. 5. Reduction of pollutants in irrigated pasture discharge passing through a functioning and channelized wetland at SFREC. TSS – total suspended solids, VSS = organic suspended solids, NVSS = sediment suspended solids, TN = total N, SRP = soluble reactive P, TP = total P.



Future Research and Demonstration
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Funding
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Publications

A.K. Knox, K.W. Tate, R.A. Dahlgren, and E.R. Atwill. Wetland filters, Irrigation and Grazing Management can Reduce *E. coli* Concentrations in Pasture Runoff. California Agriculture. Accepted with Minor Revision.

A.K. Knox, R.A. Dahlgren, E.R. Atwill, and K.W. Tate. Wetland Efficacy for Filtering Pollutants in Pasture Runoff. J. Environmental Quality. Accepted with Minor Revision.

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Black Rails in the Sierra Foothills: Distribution and habitat characteristics

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The rare and secretive Black Rail *(Laterallus jamaicensis)* is the smallest rail in North America and has a highly disjunct distribution in the U.S., inhabiting saltwater, brackish and freshwater marshes of New England, the Mid-Atlantic states, Florida, Arizona and California. The western subspecies *(L. j. coturniculus)* is listed as threatened by the California Department of Fish and Game. Potential threats include habitat loss and degradation due to water and flood-control projects, land-use changes, agriculture, and livestock grazing. Black Rails are known to have occurred throughout the San Francisco Bay since the early 1900's, but it was not until 1994 that a previously unknown population was discovered in the Sierra foothills at Sierra Foothills Research and Extension Center. Subsequent surveys conducted in the Sierra foothills from 1996-2006 have recorded Black Rails at over 142 sites in a network of hundreds of freshwater wetlands in Butte, Yuba, Nevada and Placer counties.

Habitat

California Black Rail habitat consists of dense emergent vegetation on a wet to shallow water or muddy substrate. Habitat characteristics of the Sierra foothills population are similar to those reported for other inland Black Rail populations along the Lower Colorado River, where vegetation composition, density, and water level are important determinants of suitable habitat. In contrast to the wetlands in Arizona where bulrush *(Scirpus sp.)* was frequently the dominant wetland plant, most of the Sierra foothills sites have a dominant cover of some combination of rushes *(Juncaceae)*, cattails *(Typhaceae)* and sedges *(Cyperaceae)*. In the Sierra foothills, Black Rails occupy small, perennial, shallow (<3cm deep), freshwater wetlands. Rail sites are found on a mixture of public and private lands, most between 200-700 m in elevation. Water sources include natural springs and streams in addition to water storage ponds and leaks from irrigation canals dating from the Gold Rush era to the present. Approximately 64% of occupied wetlands are fed by irrigation water, thus human management of water resources plays a large role in Black Rail conservation. Wetland sites are surrounded by a variety of land cover types including annual grassland, oak or pine woodland, riparian forest, agriculture, and urban development.

Life History

Most of what we know about Black Rails comes from studies of coastal populations in Florida and the San Francisco Bay or from the inland population along the Lower Colorado River. Pair formation is thought to occur from about February to July and the adults build a well concealed bowl nest with a woven canopy of dead or living vegetation, sometimes with an entrance ramp. Laying peaks around May 1st and clutch size ranges from 3 to 8 eggs, with an average clutch size of 6. The eggs are then incubated for approximately 17-20 days. Chicks are semiprecocial and the duration of parental care is unknown. Very little is known about Black Rails in the Sierra foothills, including how long they have occupied the area, the extent of their distribution, population trends, relationships between habitat quality and population dynamics, and dispersal distances. It is unknown if there is interchange between the foothills population and populations in the San Francisco Bay. We have found that rails are present at some wetland sites throughout the year, indicating that at least a portion of the population in the foothills is non-migratory. In addition, rails were found to rapidly colonize recently created suitable habitat (in some cases within one year), indicating a high level of local dispersal ability.

Metapopulations
Black Rails in the Sierra foothills provide an excellent model system for the study of metapopulations, or 'populations of populations'. The metapopulation concept was originally developed in an effort to understand the spatial population dynamics of pests, but has assumed a central role in population and conservation biology. The persistence of a metapopulation depends upon a balance between local (within-patch) extinctions and the recolonization of suitable habitat patches by migrants from occupied patches. Small, isolated patches are less likely to be inhabited because they will experience more extinction and less colonization than larger, less isolated patches. Our observations over the past five years have documented over 48 cases where sites occupied in one year were subsequently unoccupied in the following year (termed 'local extinctions') and 43 cases where initially empty sites were subsequently occupied in a following year (termed 'local colonizations'). These local extinctions and colonizations may be driven by both biogreographic factors and habitat quality. Key questions include:

1. *What causes local extinctions?*
    a. Are patch size and local habitat variables important?
    b. Is the surrounding landscape important?
    c. Does heavy grazing contribute to local extinctions?
    d. Does proximity to development contribute to local extinctions?
    e. What are the characteristics of sites that are resistant to local extinction?

2. *What causes local colonizations?*
    a. Are site isolation and local vegetation characteristics important?
    b. Is the surrounding landscape important?
    c. Does reduced grazing contribute to local colonizations?
    d. What are the characteristics of sites that experience local colonization?

Playback Surveys
Although Black Rails are one of the most secretive birds in North America, they readily respond to tape playbacks of their vocalizations so 'playback surveys' are an effective method to determine wetland occupancy. Using recent statistical models to estimate patch occupancy accounting for imperfect detection, three survey visits in a month were found to be sufficient to generate high site-specific probabilities of detection. We conduct our yearly surveys from June 1st to August 31st and are expanding surveys at some sites on public lands to examine occupancy dynamics during the entire year. We are also using high-resolution satellite imagery to identify potential Black Rail habitat remotely to make our search for new sites more efficient. We are currently cooperating with approximately 80 private landowners who permit us to conduct surveys on their land. Without their support we could not conduct our research—thank you!

Conclusions
While we still have a lot more research to do, it appears that Black Rails are relatively common in the Sierra foothills and their population appears to currently be stable. Black Rails depend strongly on irrigation water to provide habitat, thus changes to water availability in irrigation canals may have a big impact on the metapopulation. Local turnover of populations appears to be a normal occurrence. Rails can go locally extinct from a wetland patch, may later re-colonize it in subsequent years, and may also colonize new patches. Thus, an empty patch is not necessarily "unsuitable" habitat.

The California Rangeland Resolution

The undersigned recognize the critical importance of California's privately owned rangelands, particularly that significant portion that encircles the Central Valley and includes the adjacent grasslands and oak woodlands, including the Sierra foothills and the interior coast ranges. These lands support important ecosystems and are the foundation for the ranching industry that owns them.

WHEREAS, these rangelands include a rich and varied landscape of grasslands, oak woodlands, vernal pools, riparian areas and wetlands, which support numerous imperiled species, many native plants once common in the Central Valley, and are home to the highest diversity and density of wintering raptors anywhere in North America;

WHEREAS, these rangelands are often located in California's fastest-growing counties and are at significant risk of conversion to development and other uses;

WHEREAS, these rangelands, and the species that rely on these habitats, largely persist today due to the positive and experienced grazing and other land stewardship practices of the ranchers that have owned and managed these lands and are committed to a healthy future for their working landscapes;

WHEREAS, these rangelands are a critical foundation of the economic and social fabric of California's ranching industry and rural communities, and will only continue to provide this important working landscape for California's plants, fish and wildlife if private rangelands remain in ranching;

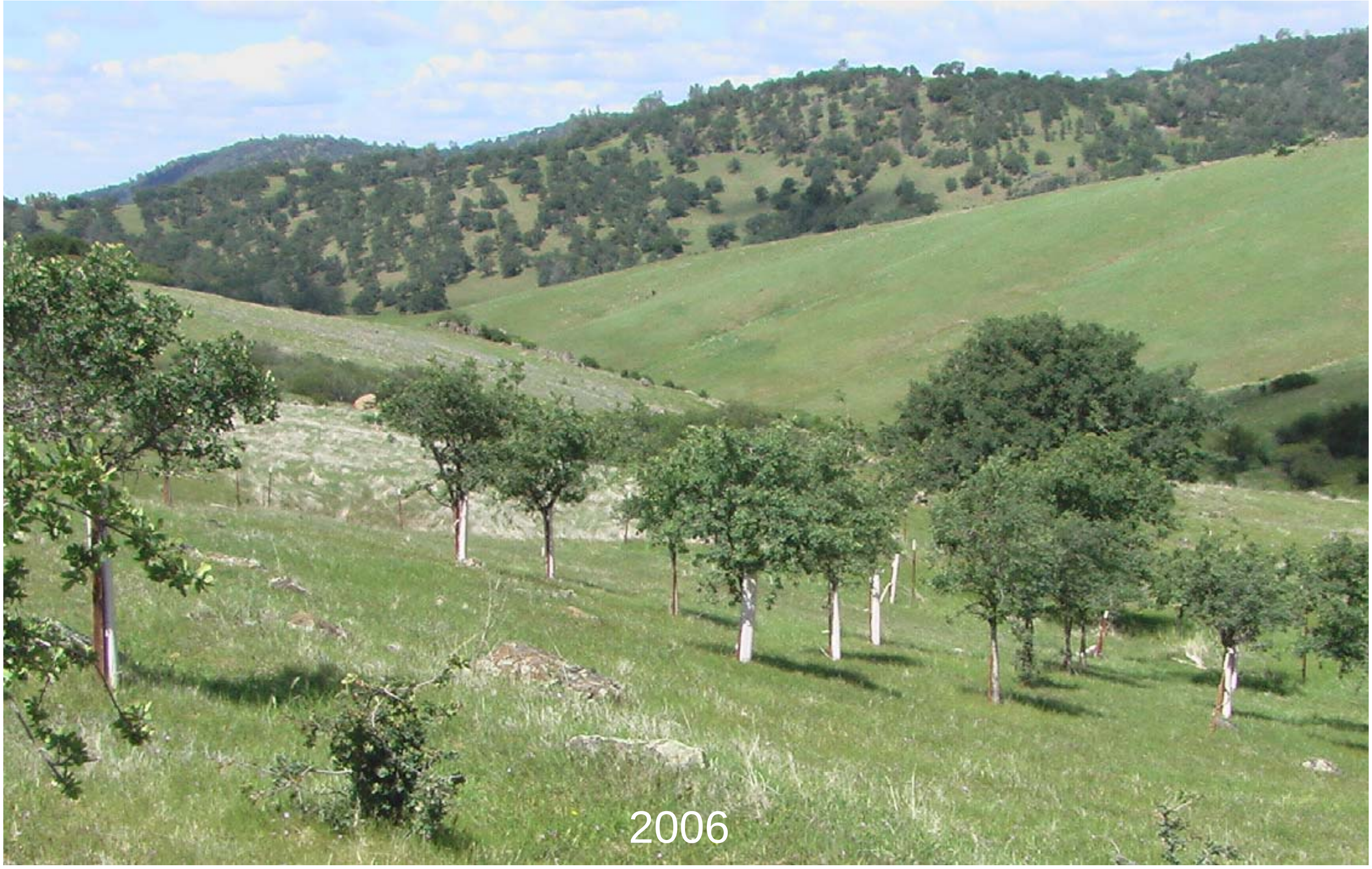
THEREFORE, we declare that it is our goal to collaboratively work together to protect and enhance the rangeland landscape that encircles California's Central Valley and includes adjacent grasslands and oak woodlands by:

- Keeping common species common on private working landscapes;
- Working to recover imperiled species and enhancing habitat on rangelands while seeking to minimize regulations on private lands and streamline processes;
- Supporting the long-term viability of the ranching industry and its culture by providing economic, social and other incentives and by reducing burdens to proactive stewardship on private ranchlands;
- Increasing private, state and federal funding, technical expertise and other assistance to continue and expand the ranching community's beneficial land stewardship practices that benefit sensitive species and are fully compatible with normal ranching practices;
- Encouraging voluntary, collaborative and locally-led conservation that has proven to be very effective in maintaining and enhancing working landscapes;
- Educating the public about the benefits of grazing and ranching in these rangelands.

***SIGNED BY*:**

Alameda County Board of Supervisors
Alameda Co. Resource Conservation District
Amador Resource Conservation District
American Farmland Trust
American Land Conservancy
Audubon California
Bureau of Land Management
Butte Environmental Council
Butte County Resource Conservation District
Calaveras Co. Resource Conservation District
California Association of Resource Conservation Districts
California Cattlemen's Association
California CattleWomen's Association
California Chapter of the International Soil and Water Conservation Society
California Department of Conservation
California Dept of Fish and Game
California Dept of Food and Agriculture
California Dept of Forestry and Fire Protection
California Farm Bureau Federation
California Grazing Lands Coalition
California Invasive Plant Council
California Native Grasslands Association
California Native Plant Society
California Oak Foundation
California Rangeland Trust
California Resources Agency
California Wildlife Foundation
California Wool Growers Association
Cal-Pac Section Society of Range Management
Central Sierra Region of Resource Conservation Districts
Central Valley Land Trust Council
City of Livermore
Defenders of Wildlife
Ducks Unlimited
El Dorado Resource Conservation District
Environmental Defense
Glenn County Resource Conservation District
Institute for Ecological Health
Jumping Frog Research Institute
Mariposa Co. Resource Conservation District
National Wild Turkey Federation
National Cattlemen's Beef Association
Natural Resources Conservation Service
Nevada Co. Resource Conservation District
Nevada County Land Trust
Northern California Regional Land Trust
Placer Co. Resource Conservation District
Sacramento River Watershed Program
San Joaquin Raptor/Wildlife Rescue Center
San Joaquin Valley Conservancy
Sierra Foothills Audubon Society
State Water Resources Control Board
Sustainable Conservation
Tehama Country Resource Conservation District
The Nature Conservancy
Trust for Public Land
Tuolumne Co. Resource Conservation District
University of California
US Fish and Wildlife Service
US Forest Service
VernalPools.org
Western Shasta Resource Conservation District
Wildlife Conservation Board
WildPlaces

March 6, 2007



Photographs courtesy of Doug McCreary

Photograph courtesy of Charlie Raguse