

# Grazing in Vernal Pools: Restoration Management Decisions

by

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## The Situation\*

The U.S. Fish and Wildlife Service has recently acquired 200 acres of open land in the Central Valley of California. This land once supported vernal pools that were home to many endemic and endangered flora and fauna. Unfortunately, over the last decade human activities such as off-road driving have significantly degraded the landscape. Because of this degradation invasive species have taken over both the uplands and the pool basins.

The acquired site has been approved for an active restoration plan that seeks to create vernal pools that are able to sustain the same biodiversity that was once observed in both its flora and fauna. The restoration management plan and its implementation are determined by a panel of individuals who will decide how the vernal pools are restored at this site. The panel members all have a unique vested interest in how the restoration project is completed. While all are amenable to following the vernal pool mitigation guidelines as put forth by the state of California, the panel members also bring their own personal biases to the decisions being made. After going through multiple iterations of the restoration plan so far, the general specifics have been determined (e.g., vernal pool density and seeding treatments). However, a big decision that is currently under debate is whether grazing should occur within the restoration site.

It is your responsibility to help this panel decide whether grazing should be excluded or allowed at this site. You, as the expert on grazing effects, will consider the main ecological consequences of grazing as presented in the assigned papers (Marty 2005 and Croel and Kneitel 2011) and from these considerations will present your rationale to the panel of experts. However, your grazing proposal submitted to the panel is a competitive proposal as others will be proposing alternatives to your grazing plan. It is imperative you use sound ecological, and potentially, economical, reasons to explain your stance on grazing within the restoration site. After hearing all of the proposals stating the merits and downfalls of grazing the panel will make a decision on whether grazing should be allowed at the site and to what degree.

## Learning Goals

1. Use evidence to construct an argument.
2. Compare and contrast ecological studies in a similar system with a similar question.
3. Use vernal pool ecological relationships to help make land management decisions.
4. Identify and work through biases to reach a management decision.

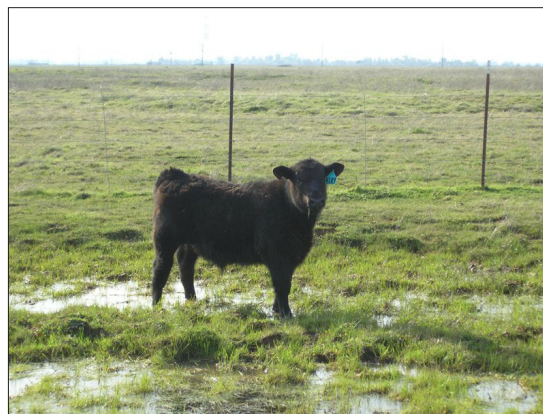


Figure 1. Cow grazing in a vernal pool during the wet season. Credit: J.M. Kneitel, used with permission.

\* Although based in fact, the situation described in this case study is a work of fiction.

### Task 1 – Interpreting Graphs

Write one or two sentences explaining the two graphs below. Then discuss with the members of your group how these graphs complement and/or contradict each other.

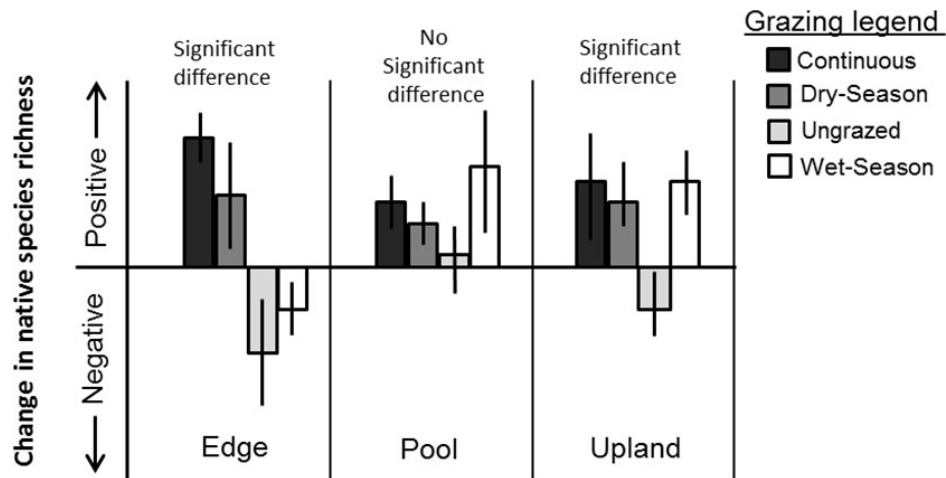


Figure 2. Adaptation of Figure 3 in Marty (2005). For actual results refer directly to article.

Explanation:

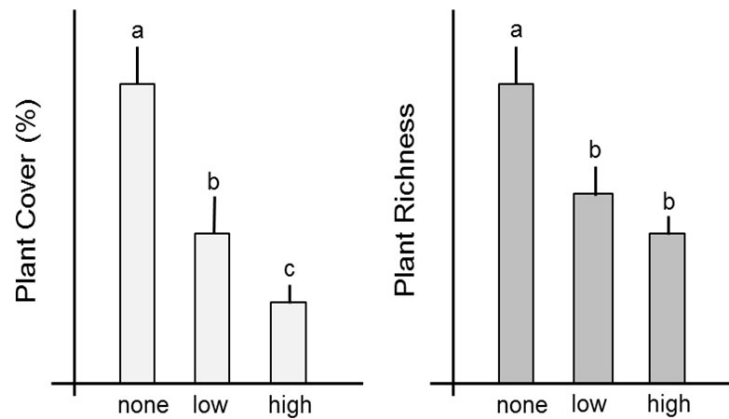


Figure 3. Adapted from Figure 2 panels “c” and “d” in Croel and Kneitel (2011). For actual results refer directly to paper.

Explanation:

## Task 2 – Ecological Consequences of Grazing

What was your grazing assignment? Please circle: **Grazing** or **No grazing**

Assuming your grazing assignment, consolidate your arguments supporting your stance. Work together as a group to write at least one ecological argument (approximately 1–3 sentences) for each of the categories applicable to your grazing regime to address when presenting your management plan (~20 min). *Hint!* Use details from the two assigned papers to provide concrete findings to help support your argument.

Use the space below to explain what might be altered with your proposed grazing plan.

*How grazing (or lack of) alters the biology of vernal pools:*

1. Vascular and non-vascular (algae) plants

2. Invertebrates

3. Vertebrates

*How grazing (or lack of) alters the abiotic side of vernal pools:*

1. Hydrology

2. Soil

3. Nutrients

*Anything else you might need to consider from an ecological perspective?*

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# Effects of Cattle Grazing on Diversity in Ephemeral Wetlands

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**Abstract:** *Cattle are usually thought of as a threat to biodiversity. In regions threatened by exotic species invasion and lacking native wild grazers, however, cattle may produce the type of disturbance that helps maintain diverse communities. Across 72 vernal pools, I examined the effect of different grazing treatments (ungrazed, continuously grazed, wet-season grazed and dry-season grazed) on vernal-pool plant and aquatic faunal diversity in the Central Valley of California. After 3 years of treatment, ungrazed pools had 88% higher cover of exotic annual grasses and 47% lower relative cover of native species than pools grazed at historical levels (continuously grazed). Species richness of native plants declined by 25% and aquatic invertebrate richness was 28% lower in the ungrazed compared with the continuously grazed treatments. Release from grazing reduced pool inundation period by 50 to 80%, making it difficult for some vernal-pool endemic species to complete their life cycle. My results show that one should not assume livestock and ranching operations are necessarily damaging to native communities. In my central California study site, grazing helped maintain native plant and aquatic diversity in vernal pools.*

**Key Words:** biodiversity, grazing, land management, species richness, vernal pools

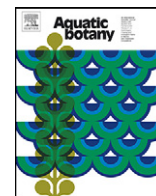
Efectos del Apacentamiento de Ganado sobre la Diversidad en Humedales Efímeros

**Resumen:** *Generalmente se piensa que el ganado es una amenaza para la biodiversidad. Sin embargo, en regiones amenazadas por la invasión de especies exóticas y carentes de apacentadores silvestres nativos, el ganado puede producir el tipo de perturbación que ayuda a mantener a diversas comunidades. Examiné el efecto de diferentes tratamientos de apacentamiento (sin apacentamiento, apacentamiento continuo, apacentamiento en época de lluvias y apacentamiento en época de sequía) sobre la diversidad de plantas y fauna acuática en 72 charcos primaverales en el Valle Central de California. Después de tres años de tratamiento, las charcas sin apacentamiento tenían 88% de más cobertura de pastos anuales exóticos y 47% de menos cobertura relativa de especies nativas que charcas con apacentamiento en niveles históricos (apacentados continuamente). La riqueza de especies de plantas nativas declinó en 25% y la riqueza de invertebrados acuáticos fue 28% menor en los tratamientos sin apacentamiento que en los apacentados continuamente. El cese de apacentamiento redujo el período de inundación entre 50 y 80%, haciendo que a algunas especies endémicas de charcos primaverales se les dificultara completar su ciclo de vida. Mis resultados muestran que no se debe asumir que la operación de ganado y de ranchos necesariamente es dañina para las comunidades nativas. En mi sitio de estudio en el centro de California, el apacentamiento ayudó a mantener la diversidad acuática y de plantas nativas en charcos primaverales.*

**Palabras Clave:** apacentamiento, biodiversidad, charcos primaverales, gestión de tierras, riqueza de especies

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# Cattle waste reduces plant diversity in vernal pool mesocosms

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## ABSTRACT

In California, much of the remaining vernal pool habitat is used for cattle grazing. Some studies suggest that grazing helps promote native plant diversity on grasslands, but the impact of grazing on plants that reside in pool basins is largely unknown. We investigated how one aspect of cattle grazing, the deposition of waste, affects these plant species by adding dung and urine to mesocosms lined with vernal pool soil. As a result of dung input, orthophosphate, conductivity, and turbidity increased in our mesocosms while dissolved oxygen decreased. Such changes in water quality are consistent with a shift toward a eutrophic state. Algal biomass and percent-cover also increased in dung-treated mesocosms. When the mesocosms dried, vascular plant species richness and percent-cover in dung-treated mesocosms were reduced by up to 54% and 87%, respectively. We attribute this to light attenuation by algal mats that flourished in the nutrient-enriched water. We also found that dung input caused significant, but weak, shifts in the composition of the vascular plant community. We conclude that cattle grazing may be detrimental to plant communities in vernal pools via increased nutrient loading, which promotes algal growth. Any beneficial effects of grazing may thus be limited to the surrounding grassland. Studies that examine the regional-scale impacts of grazing on vernal pool grasslands should separately consider the impacts to local-scale (i.e., within-pool) plant diversity, as most of the threatened and endangered plant species of California vernal pools reside primarily in pool basins.

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## 1. Introduction

Temporary ponds found in Mediterranean climate regions are generally known as vernal pools. Such pools inhabit shallow depressions that have an underlying impermeable substrate (Holland and Jain, 1981), which supports a perched water table in the rainy season. Vernal pools are typically filled with rainwater during winter and spring and are desiccated during summer and fall. These cycles result in distinct aquatic and terrestrial communities in pool basins at different times of year (Williams, 1996). Worldwide, vernal pools are a focus of conservation efforts due to their high levels of species endemism and declining numbers (Ruiz, 2008; Serrano and Zunzunegui, 2008; Zacharias and Zamparas, 2010). Vernal pools in California, for example, contain over 60 endemic plant and animal taxa (Holland and Jain, 1981; King et al., 1996), and many of these are listed as threatened or endangered (Federal Register, 2003). Furthermore, only 3–10% of the historic expanse of vernal pool habitat in California remains due to agriculture and urbanization (Holland, 1978; Keeley and Zedler, 1998).

Many of the remaining pools in California exist on grasslands used for cattle grazing (hereafter referred to simply as grazing).

Although grazing is a point of contention in California vernal pool (CVP) management, it is generally believed that management strategies should include at least some grazing (Vollmar, 2002; Federal Register, 2003; Marty, 2005). This view stems largely from empirical studies indicating that properly managed grazing can play a role in promoting native plant diversity (species richness and/or cover) on grasslands at the regional scale (Bokdam and Gleichman, 2000; Towne et al., 2005; Brudvig et al., 2007; but see Kimball and Schiffman, 2003). This conclusion appears to hold for grasslands containing vernal pools (Marty, 2005). On such grasslands, however, it is important to distinguish between the effects of grazing on plant diversity at the regional-scale (i.e., pools and the surrounding grassland matrix) versus at the local-scale (i.e., pool basins only) and to contrast the pool habitat from the surrounding grassland. Most of the threatened and endangered plants found in CVPs reside primarily in pool basins rather than in the surrounding grassland (Federal Register, 2003; Barbour et al., 2007). Studies have largely overlooked the impact of grazing on these species at the local scale. The few studies that have included such species suggest that grazing is at best neutral to native plant diversity in pool basins, regardless of the effects on diversity at the regional scale (Marty, 2005; Bouahim et al., 2010). This possible scale dependency illustrates the need for grazing studies targeting the plants that grow in pool basins.

One aspect of grazing that may be detrimental to plants in pool basins is the deposition of dung and urine. These waste products

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