Managing the Sacramento Valley Vernal Pool Landscape to Sustain the Native Flora

SHEILA J. BARRY

University of California Cooperative Extension, Natural Resource / Livestock Advisor, P.O. Box 370, Red Bluff, CA 96080

CURRENT ADDRESS: Alameda County Resource Conservation District, 1996 Holmes Street, Livermore, CA 94550 (sjgaertner@ucdavis.edu)

ABSTRACT. Vernal pools in the Sacramento Valley are essentially islands of native flora among a grassland composed primarily of exotic annual species. In managing the vernal pool landscape to sustain these islands of native flora, the integrity of the landscape's hydrology must be maintained. One management decision that may indirectly affect hydrology is complete rest from grazing. Although the native vernal pool flora may not have evolved under extensive grazing, the current hydrology and ecology of most vernal pool landscapes in the Sacramento Valley have been influenced by a livestock grazing regime. Observations of vernal pool sites under complete rest for the past fifteen years indicate that removal of livestock favors exotic annual species around the margin of vernal pools. Complete rest from livestock grazing may also alter the hydrology of the vernal pool landscape by increasing residual dry matter and altering the soil structure. Sustaining the native vernal pool flora requires vegetation management. Land managers/owners should assess current condition, understand management history, and determine a landscape goal for a vernal pool site before developing a management plan. In planning for management with grazing livestock, land managers/owners should consider the effects of different grazing animal species, season of grazing, and grazing intensity. Monitoring plant species composition, residual dry matter, and utilization will allow land managers/owners to adjust their management plan to make progress towards the landscape goal.

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INTRODUCTION

The grasslands of the Sacramento Valley are composed of a great variety of exotic annual plant species. These plant species were first introduced in 1769 with the arrival of the Spanish missionaries and have spread and flourished throughout the Sacramento Valley in areas with and without livestock grazing. Despite the invasion of exotic annual plants, one place native grassland plants have thrived is in and around vernal pools that are still relatively intact. Holland and Jain (1984) found that vernal pools are typically dominated by native plants. They identified about two hundred plant species that grow in vernal pools and determined that ninety percent of them are native. Vernal pools in the Sacramento Valley thus represent ecological islands in California's grasslands.

Native plants have persisted in vernal pools, because they can cope with seasonal hydrologic extremes from inundation to desiccation. Exotic annual plants are generally not adapted to survive such extremes. The hydrologic extremes of vernal pools occur because of the nature of their water-holding capacities. A vernal pool occupies a depression which is poorly drained because a hard subsurface layer prevents downward drainage. Any activity or event that lengthens the inundation period of a vernal pool so that marsh or pond species can occupy the site, threatens continued survival of the vernal pool's biota. Similarly, any activity or event that improves the drainage or infiltration and shortens the length of inundation also threatens the integrity of the vernal pool and its native biota. Bauder (1987) studied the effect of altered pool hydrology on the Miramar Naval Air Station in southern California. She reported that some native vernal pool plant species were favored by at least two weeks of standing water which eliminated exotics. Other native vernal pool plant species required longer periods of standing water to flourish. Bauder found that pools with limited water-holding capacity had a higher percentage of exotic plants. Maintaining the hydrologic integrity of a vernal pool is paramount to maintaining its associated native plants.

Threats to Vernal Pools

Urban development, water supply/flood control activities, and conversion of land to intensive agricultural use are events that can directly alter the infiltration, drainage, and general hydrology of a vernal pool (Federal Register, 1992). Because the impact of these events is rather obvious and they are typically part

of a land planning process, they can be prevented or regulated to conserve vernal pool habitat.

Other activities that may threaten vernal pools may be overlooked because their impact to vernal pool hydrology is indirect. In particular, some land management activities alter surface and soil organic matter, soil bulk density, or other factors that influence hydrology. One management decision, either intentional or otherwise, that is often overlooked, but may indirectly alter vernal pool hydrology and threaten its a native plant species is complete rest from livestock grazing. Under complete rest the vernal pool landscape is fenced off from grazing livestock, and otherwise left alone. Although complete rest may seem like an appropriate way to protect a vernal pool and its associated biota, removing grazing livestock from the vernal pool landscape of the Sacramento Valley has consequences for the vegetation and hydrology of the vernal pool landscape.

Current Management of the Sacramento Valley's Vernal Pool Landscape

Although native vernal pool plants may not have evolved under extensive grazing, the current landscape surrounding the vernal pools of the Sacramento Valley has been subject to various levels of grazing. Most of the early settlers in the Sacramento Valley depended on livestock for their livelihood. Consequently, most of large open areas of the valley not under cultivation have been grazed for more than 150 years. Tehama County alone has provided grazing for up to 300,000 sheep and up to 60,000 head of cattle (USDA, 1967). Currently, there are about 3,000 sheep in Tehama County and about 50,000 cattle.

Management of livestock in the Sacramento Valley however, has changed during the past 150 years. In the early years most grazed areas were not fenced. Today most of the acreage is fenced and crossfenced. This allows for rotational grazing of livestock. Additionally in the early years livestock may have remained in the valley all year long. Today the valley, including those areas with vernal pools, is typically grazed from November to May.

When resource managers and landowners develop plans to conserve vernal pool habitats, it is imperative they recognize that the current vernal pool landscape has been altered with the proliferation of exotic plant species and the impact of livestock grazing. For example, the impact of exotic plant species and livestock grazing on the vernal pool landscape should be considered in conservation efforts to protect the federal- and state-listed endangered Butte County Meadowfoam (*Limnanthes floccosa* ssp. *californica*). Butte County Meadowfoam occurs in patches on the upper edges of the wetland boundary and along the side slopes of swales. A survey conducted by Dole (1988) identified three major centers of Butte County Meadowfoam populations. The location, number of individual plants, and seed set of these populations were carefully described. Whether or not the site was grazed was also noted. The survey indicated that the all the populations with the exception of one were at sites currently managed with grazing livestock. The ungrazed population was reported to be a poor site for Butte County Meadowfoam because of competition from the exotic annual species, Ryegrass (*Lolium multiflorum)* and Filaree (*Erodium botrys)*. A correlation between the lack of grazing and competition from exotic annual plants cannot be documented in this case, because this site may also have been impacted by construction disturbance. However, it should be noted that all known populations of Butte County Meadowfoam occupy sites that had been historically grazed.

Despite the previous management history of lands occupied by Butte County Meadowfoam populations, grazing has not being used as a management tool in the current conservation efforts. A cyclone fence was constructed around the Doe Mill Preserve for protection from human and animal trespassers. Medusahead (*Taeniatherum caput-medusae)* and other exotic annual grasses are flourishing inside the cyclone fence. Removing grazing livestock does not result in the disappearance of exotic annual plant species from a vernal pool landscape. Instead removing grazing livestock may further benefit the exotic annual grass species.

OBSERVATIONS ON COMPLETE REST OF THE VERNAL POOL LANDSCAPE

Currently, there are no published data on the effects of grazing on vernal pools; however in 1993, a demonstration project to study grazing impacts on vernal pools was initiated on the Vina Plains, Tehama County. The demonstration project includes 4 pairs of vernal pools. Fencing was installed, March 1993, to exclude grazing livestock from one pool in each pair. Vegetation and invertebrate populations are being monitored in each pool. The demonstration project also includes two vernal pool sites from which grazing livestock have been excluded for the past 15 years. These sites were inadvertently excluded from grazing livestock after the installation of cross-fencing on the property. These sites provided the opportunity to observe the long-term effects of excluding livestock from vernal pool sites.

Methods. The vernal pool sites were observed weekly in April and May 1995. Permanent photo points were established. Distinct bands of flora were measured with a tape measure in three spots at each location: Site A, Site B (grazed), and Site B (ungrazed) to determine width. Plant species composition at each site was determined by averaging ocular estimates of plant species composition inside a 1-ft sq sampling quad placed randomly at ten spots in each vernal pool. At ungrazed sites, the landscape immediately surrounding the vernal pools was throughly investigated for presence of native vernal pool flora. Individual native plants were counted.

Site A. This site of about 15 acres of vernal pool landscape has been fenced to exclude livestock for the past 15 years. Observations were made at the largest vernal pool on this site, approximately 3200 sq. ft. The uplands around this pool were dominated by Medusahead. Some areas had a thick gray thatch of Medusahead. Seedlings of Medusahead and no other native or non-native plants were found growing through this thatch. Medusahead grows right up to the edge of the vernal pool. Dry matter samples collected at the edge of the vernal pool in the late spring indicate that there are approximately 950 lb. per acre of Medusahead thatch surrounding the pool. Few vernal pool margin plants were found around the edge of this vernal pool. Less than 5 plants of Rosy Meadowfoam (*Limnanthes douglasii* ssp. *rosea*) could be found around the edge of this vernal pool. Fremont's Goldfields (*Lasthenia fremontii*) and Fremont's Tidy-Tips (*Layia fremontii*) were also very scarce, with only one or two plants present. Within the vernal pool, Vasey's Coyote-thistle (*Eryngium vaseyi*) is the most common plant, accounting for approximately 35% of the vegetation cover in the vernal pool. Popcorn-flower (*Plagiobothrys* sp.) is also quite common in this vernal pool, accounting for approximately 25% of the vegetation cover. Woolly Marbles (*Psilocarphus brevissimus*), Two-horned Downingia (*Downingia bicornuta*) and Navarretia (*Navarretia leucocephala*) were also present but scarce.

Site B. This 10 acre site includes a vernal pool that extends well beyond the fence line onto adjacent property, which is seasonally grazed. Approximately 4/5 of this vernal pool, just over 9000 sq. ft is on the grazed property. The grazed part of the pool does not have a distinct edge, native plants associated with vernal pool landscapes are scattered across the landscape among a variety of non-native grasses and forbs.

Early in the spring a wide band (10 to 15 ft) of *Limnanthes douglasii* ssp. *rosea* rings the grazed side of the pool. *Lasthenia fremontii* fills in closer and later in the spring with a band 10 to 20 feet wide. Within the grazed bands of *Limnanthes douglasii* ssp. *rosea* and *Lasthenia fremontii* microdepressions created by hoof prints 3 to 6 inches deep include a variety of vernal pool plants including *Navarretia leucocephala, Psilocarphus brevissimus,* and *Plagiobothrys* sp.. Residual dry matter, plant residue, surrounding the edge of the grazed part of this pool was clipped and weighed after livestock were removed in spring 1995. Approximately 500 lb. per acre of dry matter surrounded the grazed edge of this vernal pool. This included exotic annual grasses, clover, and native vernal pool plants

In contrast, the edge of the vernal pool that had complete rest for the past fifteen years was very distinct. The non-native grass, *Lolium multiflorum* grew right to the edge of the pool. Native plants are not evident across the vernal pool landscape. Judging from the pool edge on the grazed side of the fence the vernal pool vegetation signature has receded as much as 12 feet in the rested part of the pool. The organic matter provided by the invading *Lolium multiflorum* and the lack of animal impact seems to have changed the hydrology of the rested vernal pool margin. In the early spring the distinct edge of this part of the pool was distinguished by a narrow band less than one foot wide of *Limnanthes douglasii* ssp. *rosea*. A few *Limnanthes douglasii* ssp. *rosea* seeds managed to germinate within the first few inches of the area occupied by *Lolium multiforum*, but they were barley visible. As on the grazed edge of this pool, *Lasthenia fremontii* was found in a band toward the center of the pool from the band of *Limnan-thes*; however, on the rested pool edge this band was narrower, one to three feet. Unlike the grazed part of this pool *Navarretia leucocephala* was not present in the pool or around the margins. The edge of the rested part of this vernal pool had approximately 2800 lb. of dry matter per acre.

Few differences in species composition were noted in the center of this vernal pool on the grazed versus ungrazed side. Dwarf Spikerush (*Eleocharis acicularis*) dominated in patches throughout the grazed and ungrazed parts of this vernal pool. *Eleocharis acicularis* accounted for about forty-five percent of the vernal pool plants. *Downingia bicornuta* was also dominant accounting, for nearly thirty percent of the vernal pools plants in the center of the vernal pool. *Eryngium vaseyi* was scattered around the edges, but accounts for less than two percent of the vernal pool plants.

DISCUSSION

A significant amount of vegetation can grow around the edges of vernal pool on an ungrazed site. Many studies conducted on grasslands in temperate areas of the United States have shown that the amount of runoff is significantly influenced by the amount of vegetation. Runoff decreases with increasing vegetation (Blackburn, 1975). The vegetation retards runoff and generally allows a greater opportunity for infiltration into the soil. Standing dry or dead vegetation may also reduce runoff by increasing net rain loss due to interception and direct evaporation. Liacos (1962) found that on California's annual grassland net interception of rainfall was about 4 mm higher under complete rest than under light grazing and 6 mm higher than under heavy grazing. Interception of rainfall is clearly a function of vegetation surface area. Although surface runoff may not be important for initially filling a vernal pool, it may help to regulate fluctuations in a pool's water level later in the season (Hanes et al., 1990). Accumulation of dry matter around a vernal pool could impact the length of inundation particularly in a low rainfall year.

Complete rest from livestock grazing may also impact hydrology of a vernal pool site by altering soil infiltration capacity. Gifford and Hawkins (1978) reviewed literature on the hydrologic impacts of grazing intensities and concluded that there is an influence of grazing on infiltration. Areas under complete

rest had rates of infiltration that were statistically higher than grazed areas at any intensity. They also noted that light and moderately grazed areas were statistically identical in their impact of infiltration. Their review examined studies conducted on a variety of soil types in Canada, Australia, and throughout the United States. Gifford and Hawkins's conclusions support previous research by Liacos (1962), who studied the influence of livestock grazing on water yields on California's annuals grasslands. He found that under complete rest from grazing infiltration, percolation, and water storage capacity were increased. He concluded that these factors may eventually affect vegetational change.

In addition to impacting vernal pool hydrology, complete rest from grazing may also alter the soil surface and decrease the diversity of vernal pool microecosystems around a vernal pool. Without the impact of grazing livestock, a vernal pool on a completely rested site develops a smooth bottom free of microdepressions created by hoof prints. Although hoof impact disrupts soil structure and surface and the shearing action may destroy some vegetation (Vallentine, 1990), the microdepressions created by hoof prints may create a diversity of habitats for vernal pool plants and animals. These microdepressions may lengthen the period of inundation in spots around the edges of a vernal pool or in shallow pools. For example, microdepressions created by animal disturbance have created habitat for Hoover's Downingia (*Downingia bella*) in shallow pools. *Downingia bella* typically covers the bottom of deeper pools. Similarly, a microdepression created by a hoof print may provide a place of refuge for a fairy shrimp to complete its life cycle during a low rainfall year. Additional research is required to understand the role of microdepressions across a vernal pool landscape.

The changes in vernal pool hydrology that may occur with complete rest from grazing are actually interrelated with the invasion of exotic annual plants. Exotic annual plants can significantly impact the edge of vernal pools or shallow vernal swales and the vernal pool plant species that are adapted to these areas. Medusahead as well as Annual and Perennial Ryegrass (*Lolium multiforum* and *Lolium perenne)* are exotic annual grasses which are particularly competitive in marginal vernal pool areas in the Sacramento Valley. These annual species are aggressive and highly competitive. Because they evolved in their native ranges under thousands of years of heavy grazing and periodic drought, many exotic annuals are capable of producing some seeds under the most adverse grazing disturbances and weather regimes. These exotic annual grasses will take advantage of any opportunity to germinate around the edge of a vernal pool if a change in hydrology permits. As they become established in an area their presence can change the hydrology further to support their survival. As noted in the field observation of a pool under complete rest, both Medusahead and Annual Ryegrass were able to thrive right up to the high water mark of the vernal pool. Exotic annuals clearly present a formidable obstacle to re-establishment and sustainability of native plants on California's grasslands (Menke, 1992).

Sustaining vernal pools as habitat for endangered vernal pool species, such as Sacramento Orcutt-grass (*Orcuttia pilosa*), Slender Orcutt-grass (*Orcuttia tenuis*) and Colusa Grass (*Neostapfia colusana*), can be difficult in a vernal pool managed with complete rest from grazing. Crampton (1959) found that "the best stands of either *Orcuttia* or *Neostapfia* occur mostly in the absence of other vegetation... The presence of the ubiquitous vernal pool (perennials) coyote thistle (*Eryngium vaseyi*) and the sedge *Eleocharis palustris*, restrict the density of *Orcuttia* and *Neostapfia*." Observations across a fenceline that straddles the main portion of a vernal pool at Rancho Seco in Sacramento County suggest that a managed grazing regime may help to control *Eleocharis*. The density of *Eleocharis* on the side of the pool that was heavily grazed was significantly reduced (Stone et al., 1987).

Grazing Management Consideration for the Sacramento Valley's Vernal Pool Landscape

The first step in developing a management plan for vernal pool habitat is to define the landscape goal. Vegetation composition and microtopography of a site can be manipulated by management. Without a clear landscape goal it is impossible to determine which management tools to apply. Assessing current conditions including knowledge of management activities or events that have affected the site is essential. Some level of vegetation management will be necessary to sustain the native vernal pool flora. Although fire, mowing, or herbicide may be effective tools to manage vernal pool vegetation, the current vernal pool landscapes in the Sacramento Valley have developed under grazing. Removing livestock from a landscape that has developed with grazing must be considered a disturbance. However, improperly managed grazing can also be a disturbance. Livestock can not be simply turned out to graze, grazing needs to be managed.

Considerations for a grazing management plan should include (1) grazing animal species, (2) grazing intensity, and (3) time of grazing. Cattle, sheep and horses are the predominant species that have grazed vernal pool landscapes. Substantial differences exist between these species in forage preference and in grazing habits. For example, sheep can graze closer to the ground than cattle and tend to prefer broad-leaved plants, rather than grasses. Cattle and horses consume mostly grasses, but will graze on some forbs and browse. However, horses can graze closer than cattle. Differences in grazing selection and behavior should also be recognized within a species. Cattle that will walk further to water may be less likely to loaf around wetland areas as vernal pools. Grazing intensity or the amount of animal demand on available forage should also be managed. If forage surrounding a vernal pool is being heavily used either

the site is overstocked or distribution of the livestock is poor. Providing water or supplemental feeds at a different location are very effective tools to improve distribution. Time of grazing can impact species utilization and composition. In the early spring, forage is high in quality and quantity, and livestock can make good use of exotic annual grasses on the uplands surrounding vernal pools. As the pools dry up and the annual grasses die, livestock may be attracted to the green plants in and around a vernal pool. Decreasing residual dry matter to a moderate level (approximately 500 lb. or less) around a vernal pool before fall germination should help to encourage vernal pool margin species. Monitoring plant species composition, residual dry matter, and utilization will allow land managers/owners to adjust their management plan to make progress towards their landscape goals.

CONCLUSION

The extent to which grazing animals impacted vernal pool ecosystems before the arrival of domestic livestock is uncertain. Grasslands surrounding the vernal pools in the Sacramento Valley have changed significantly since the arrival of the Spanish missionaries. Grazing livestock and exotic annuals species both became major components of the grassland ecosystem in California. It is this "newly" developed grassland that must be managed to conserve California's endemic flora and fauna. Unfortunately, removing livestock does not made the exotic annual species disappear. In fact, removing livestock can promote certain exotic annual species such as Annual Ryegrass and/or Medusahead. Management of California's vernal pool habitats to conserve endemic flora should not only prevent exotic species from invading vernal pools but also maintain the hydrologic integrity of the site. Additional research is required to identify grazing management strategies that best maintain the viability of a vernal pool habitat for the native species.

LITERATURE CITED

Bauder, E.T. 1987. Threats to San Diego Vernal Pools and a Case Study in Altered Pool Hydrology. Pages 209-213 *in:* T.S. Elias (Editor). Conservation and Management of Rare and Endangered Plants. Proceeding of a California Conference on the Conservation and Management of Rare and Endangered Plants. The California Native Plant Society, Sacramento, CA.

Blackburn, W.H. 1975. Factors influencing infiltration and sediment production of semi-arid rangelands in Nevada. Water Resources Research 11:929-937.

Crampton, B. 1959. The grass genera Orcuttia and Neostapfia: a study in habitat and morphological specialization. Madroño 15:97-110.

Dole, J. 1988. Results of a Field Survey for the Butte County Meadowfoam in the Vicinity of the City of Chico, California. City of Chico, Chico, CA.

Federal Register. 1992. Endangered and threatened wildlife and plants; proposal to determine endangered status for four fairy shrimp and the vernal pool tadpole shrimp in California. Federal Register 57(90):19857-19862.

Gifford, G.F. and R.H. Hawkins. 1978. Hydrologic impacts of grazing on infiltration: A critical review. Water Resources Research, 14(2):305-313.

Hanes, W.T., B. Hecht, and L.P. Stromberg. 1990. Water relationships of vernal pools in the Sacramento region, California. Pages 40-60 *in:* D.H. Ikeda and R.A. Schlising (Editors). Vernal pool plants-their habitat and biology. Studies from the Herbarium No. 8, California State University, Chico, CA.

Holland, R.F., and S.K. Jain. 1984. Vernal pools. Pages 515-536 *in:* M.G. Barbour and J. Major (Editors). Terrestrial Vegetation of California. John Wiley and Sons, New York, NY.

Liacos, L.G. 1962. Water yields as influenced by degrees of grazing in the California winter grasslands. Journal of Range Management 15:34-42.

Menke, J.W. 1992. Grazing and fire management for native perennial grass restoration in California grasslands. Fremontia 20(2):22-25.

Stone, R.D., G.L. Clifton, W.B. DaVilla, J.C. Stebbins, and D.W. Taylor. 1987. Endangerment Status of the Grass Tribe Orcuttieae and *Chamasyce hooveri* (Euphorbiaceae) in the Central Valley of California. Pages 239-247 *in:* T.S. Elias (Editor). Conservation and Management of Rare and Endangered Plants – Proceeding of a California Conference on the Conservation and Management of Rare and Endangered Plants. California Native Plant Society, Sacramento, CA.

United States Department of Agriculture. 1967. Soil Survey. Tehama County California. pp 94-95.

Vallentine, J. 1990. Grazing Management. Academic Press: San Diego, CA.