Vernal Pools on California's Annual Grasslands

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The rangelands of the Northern Sacramento Valley are comprised of a great variety of exotic annual plant species. These plant species were first introduced in 1769 with the arrival of the Spanish Missions and continued from Gold Rush days to today. By their very nature, exotic annual species are aggressive and highly competitive. Because they evolved during thousands of years of heavy grazing and periodic drought in their native habitat, exotic annuals are capable of producing some seed under the most adverse grazing disturbances and weather regimes. Consequently, they present a formidable obstacle to re-establishment of native plants (Menke 1992). Exotic annuals now comprise the stable communities of most of California's grasslands (Heady 1977).

Despite the invasion of exotic annuals, native plants have thrived on California's grasslands in vernal pools. In fact, Holland and Jain (1984) found that vernal pools are typically dominated by native plants. Vernal pools are seasonally dry depressions which catch and hold water from winter precipitation until it evaporates into the air and/or percolates into the soil in the spring or summer. They are a type of wetland unique to California and a few other places in the world. Vernal pools provide habitat for an unusual diversity of native crustaceans, grasses and wildflowers. These islands of native flora and fauna should continue to exist and thrive among the exotic annuals as they have for the past 100 years if they are protected and properly managed.

Threats to Vernal Pools in the Sacramento Valley

In 1978 the California Native Plant Society estimated that 90% of California's Central Valley vernal pool environments had been eliminated (Holland, 1978). Currently, three vernal pool plants and four vernal pool invertebrate species occurring in the Sacramento Valley are listed as threatened or endangered under the Federal Endangered Species Act. Vernal pools and their associated flora and fauna are threatened by a variety of human-caused activities that change the pool's hydrology including urban development, water supply/flood control activities and conversion of land to agricultural use (Federal Register 1992). These habitats are also indirectly affected by modifications of surrounding uplands that alter a vernal pool's watershed.

Beyond changes in vernal pool hydrology, the introduction of exotic species is the major threat to vernal pool habitats. Stone et al. (1987) noted that competition from weeds is one of the most significant impacts to the vernal pool annual grass populations. They found that Cocklebur *(Xanthium strumarium)*, Bindweed *(Convolvulus arvensis)*, etc. in large vernal pools threatened the habitat of two endangered vernal pool plant species, Hairy Orcutt Grass *(Orcuttia pilosa)* and Hoover's Spurge *(Chamaesyce hooveri)*. In smaller, swalelike pools they found the introduced perennial grass, Italian Ryegrass *(Lolium multiforum)*, to be a problem for the endangered vernal pool plant, Greene's Tuctoria *(Tuctoria greenei)*.

The invasion of weedy exotic species into vernal pool habitat can actually be interrelated with changes in hydrology. The frequency and abundance of weedy upland species in vernal pools tends to increase during drought years (Holland and Jain, 1984). Native vernal pool species are adapted to the seasonal pattern of

Ungrazed Vernal Pool (excluded from livestock grazing for the past 10 years) Vina Plains, Tehama Co. April 1993.

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Grazed Vernal Pool Vina Plains, Tehama County, Calif. April 1993.

drought and standing water in the pools. If the period of standing water is reduced, the invasion of exotic species is promoted. As exotic herbs and grasses invade, the period of inundation may be further reduced. Bauder (1987) demonstrated that the percentage of vegetation in a vernal pool which is exotic is closely tied to length of inundation. When the pools were only inundated for four weeks or less during a year, one-third of the species around the pools' margin were exotic. With over two months of inundation less than 10 percent of species around the pool were exotic.

Grazing- A Tool to Preserve Vernal Pool Habitats

Grazing may be used as a tool to maintain vernal pool hydrology and prevent the invasion of exotic weeds. Livestock have grazed in and among most vernal pools in the Sacramento Valley for at least a century. Although, there are no published data on the effects of grazing on vernal pools, some biologist have made mention of grazing impacts on vernal pools. Zedler (1987) stated that moderate cattle or horse grazing does not seem to pose much of a threat to the persistence of vernal pool plants despite the "disruptive" effect of trampling. He also noted that grazing may even help to perpetuate vernal pool plants. When horses were removed from a heavily grazed horse pasture on the University of California Santa Barbara campus the abundance of vernal pool species seemed to decline in proportion to the increase in nonpool species.

The effects of grazing on rangeland resources are most certainly as complex as the various ecosystems in which livestock grazing occurs. It is usually easy to point out examples of resource degradation caused by overgrazing; however, instances where properly managed grazing maintains ecological balances and/or promotes biological diversity are probably numerous, especially on California's annual grassland. Properly managed grazing in vernal pool habitats on California's annual rangeland may be one such instance where ecological balances and biological diversity are enhanced.

Grazing to Maintain Vernal Pool Hydrology

Based on limited monitoring and personal observations of vernal pools in the Sacramento region Hanes et al. (1990) reported that direct precipitation appears to be a dominant input initially filling pools during the winter. Later in the season, flucuations in a pool's water level may largely be a result of surface runoff. In fact, surface runoff seems to be essential for maintaining an adequate inundation period. 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 in proportion to an increase in the amount of vegetation (Blackburn 1975). Vegetation cover retards runoff and generally allows for greater opportunity for water infiltration. Standing dry or dead vegetation may also increase net rain loss due to direct evaporation. Grazing animals may help to maintain the hydrology of the uplands surrounding vernal pools by preventing the excessive accumulation of plant material.

Mechanical impact by grazing animals may also be important for maintaining the vernal pool hydrology by sustaining the soil conditions that create vernal pool habitat. Gifford and Hawkins (1978) reviewed literature on the hydrologic impacts of grazing intensities. They concluded that ungrazed rates of infiltration were statistically different from grazed rates at any intensity. They found no significant difference between light and moderate grazing, but a distinct difference between heavy grazing and light or moderate grazing.

Liacos (1962) studied the influence of livestock grazing on water yields and bulk density on California's annual grasslands. He found that sites heavily grazed for more than 35 years had more dense and more shallow soil than ungrazed sites. Water yield was many times greater under heavy grazing. Liacos concluded that when heavy grazing occurred year after year the soil forming process was slowed down. It would appear that vernal pool habitats on annual grasslands can be maintained if current grazing intensities continue.

In addition to maintaining the hydrologic aspects of a vernal pool, the trampling of a grazing animal may also influence the diversity of microecosystems within a vernal pool. When the vernal pools are wet, animal disturbances can cause microdepressions. These microdepressions may enable shallower pools to provide habitat for vernal pool plants and animals gener-

ally found in deeper vernal pools. For example, *Downingia bella* covers the bottom of deeper pools, but is also found in shallower pools when deeper microdepressions held water for a prolonged time.

Grazing to Prevent Invasion of Weedy Species

Four factors (precipitation, temperature, soil characteristics, and plant residue or litter) largely control productivity and seasonal species composition of California's annual grasslands. Management of plant residue is the factor that can be most readily controlled by a rangeland manager. Low amounts of residue in fall favors the growth of a diversity of plants including low-stature, spring-maturing forbs, such as filaree (*Erodium* ssp.) and summer annuals, such as turkey mullein *(Eremocarpus setigerus)*. In the absence of livestock, plant residue can accumulate and annual grassland habitats are often dominated by tall dense stands of grasses such as ripgut brome *(Bromus diandrus)*, medusahead *(Taeniatherum caput-medusae)*, or wild oats *(Avina fatua)*. Medusahead is one of the dominate annual grasses surrounding many vernal pools in the Sacramento Valley.

Once medusahead becomes established, it grows in dense stands, forming a mat of stems 2 to 5 inches thick. Evidence indicates the dense litter cover is important in the competitive relationship because other plants fail to grow under litter cover (Evans and Young 1970). Field observations in and around ungrazed pools in the Sacramento Valley indicate that a dense thatch of medusa head can develop right to the pool's edge. A managed livestock grazing program can control medusahead and reduce the thatch it creates. This allows for a greater diversity of rangeland plants including wildflowers commonly found around the edges of vernal pools.

Similarly, managed grazing can sustain vernal pool habitat for stands of *Orcuttia* and *Neostaphia*, endangered vernal pool plants. Crampton (1959) found that "the best stands of either *Orcuttia* or *Neostaphia* 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*, restricts the density of *Orcuttia* and *Neostapfia*." Observations across a fenceline that straddles the main portion of a vernal pool at Rancho Seco in Sacramento suggest that a managed grazing regime may help to control *Eleocharis*. The density of *Eleocharis* on the side of the pool which is heavily grazed is significantly reduced (Stone et al 1987).

Conclusion

After considering ecological factors governing vernal pools and California's annual rangeland, as well field observations, a case may be made for the benefits of livestock grazing vernal pool habitats on California's annual grasslands. Native vernal pool plants and fauna have co-existed in these grazed ecosystems for at least the past century. The extent to which grazing animals impacted vernal pool ecosystems before the arrival of Spaniards in California is debatable, however with the arrival of Spaniards the grasslands surrounding the vernal pools in the Sacramento Valley significantly changed. It is this "newly" evolved grassland, full of exotic aggressive annuals, that must be managed if California's endemic flora and fauna species are to be conserved. Management of California's annual grasslands with vernal pool habitat should not only prevent exotic species from invading vernal pools, but also should not compromise the hydrology that creates vernal pools. Excluding livestock grazing from vernal pool habitats without an alternative proven method to manage the surrounding grasslands could (and has) resulted in a decline in biological diversity.

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