Selected References
Grazing for Biological Conservation

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Weiss, S.B. 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-poor Grasslands for a Threatened Species. Conservation Biology. 13(6): 1476-1486.

Abstract
Nutrient-poor, serpentinitic soils in the San Francisco Bay area sustain a native grassland that supports many rare species, including the Bay checkerspot butterfly (*Euphydryas editha bayensis*). Nitrogen (N) deposition from air pollution threatens biodiversity in these grasslands because N is the primary limiting nutrient for plant growth on serpentinitic soils. I investigated the role of N deposition through surveys of butterfly and plant populations across different grazing regimes by literature review, and with estimates of N deposition in the region. Several populations of the butterfly in south San Jose crashed following the cessation of cattle grazing. Nearby populations under continued grazing did not suffer similar declines. The immediate cause of the population crashes was rapid invasion by introduced annual grasses that crowded out the larval host plants of the butterfly. Ungrazed serpentinitic grasslands on the San Francisco Peninsula have largely resisted grass invasion for nearly four decades. Several lines of evidence indicate that dry N deposition from smog is responsible for the observed grass invasion. Fertilization experiments have shown that soil N limits grass invasion in serpentinitic soils. Estimated N deposition rates in south San Jose grasslands are 10-15 kg N/ha/year; Peninsula sites have lower deposition, 4-6 kg N/ha/year. Grazing cattle select grasses over forbs, and grazing leads to a net export of N as cattle are removed fro slaughter. Although poorly managed cattle grazing can significantly disrupt native ecosystems, in this case moderate, well-managed grazing is essential for maintaining native biodiversity in the face of invasive species and exogenous inputs of N from nearby urban areas.

Hayes, G.F. and K.D. Holl. 2003. Cattle grazing impacts on annual forbs and vegetation composition of Mesic Grasslands in California. Conservation Biology. 17(6):1694-1702.

Abstract
Livestock grazing represents a major human alteration of natural disturbance regimes in grasslands throughout the world, and its impacts on plant communities have been highly debated. We investigated the impact of cattle grazing on the California coastal prairie plant community with a focus on native annual forbs, a number of which are of conservation concern. In spring 2000 and 2001, we surveyed the vegetation community

composition, vegetation structure, and soil chemical parameters at 25 paired grazed and ungrazed sites over a 670-km range of the ecosystem. Native annual forb species richness and cover were higher in grazed sites, and this effect was concomitant with decreased vegetation height and litter depth. Soil properties explained less of the variation. Exotic annual grass and forb cover were higher in grazed sites. Native grass cover and species richness did not differ in grazed and ungrazed sites, but cover and species richness of native perennial forbs was higher in ungrazed sites. Our results suggest that cattle grazing may be a valuable management tool to conserve native annual forbs in the ecosystem we studied but that grazing differentially affects the various life history guilds. Therefore, land managers must focus on creating a matrix of disturbance regimes to maintain the suite of species native to these mesic grasslands. The results of this and other studies highlight the importance of considering the adaptation of vegetation communities to disturbance in making grazing management recommendations.

Marty, JT. 2005. Effects of cattle grazing on diversity in ephemeral wetlands. Conservation Biology 19:1626-1632.

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.

Hayes, G. 1998. The Saga of the Santa Cruz Tarplant. Four Seasons 10 (4): 18-21.

Introductory paragraphs
Conservationists are confident when they swiftly respond to the question of the two greatest threats to California's prairies. The discussions get heated and longer, though, when they try to name the third major threat. And yet, when declining trends in annual wildflowers like the endangered Santa Cruz tarplant are studied, the third greatest threat becomes quite obvious.

The two primary threats to our prairies are undoubtedly those of human development and invasion by exotic weeds. As indicated by the trend in the Santa Cruz tarplant, the next major threat is the cessation of grazing. This article focuses on one population of tarplant that flourished alongside and under cattle, disappeared after their removal, and reappeared years later after extreme human intervention.

Germano, D.J., G.B. Rathbun, and L.R. Saslaw. 2001. Managing exotic grasses and conserving declining species. Wildlife Society Bulletin 29(2):551-559.

Abstract
California's southern San Joaquin Valley, as with much of western North America, has been invaded by exotic plant species during the past 100-200 years. The herbaceous cover of these introduced grasses and forbs often creates an impenetrable thicket for small-ground dwelling vertebrates. Contrary to some earlier descriptions of upland habitat of southern and western San Joaquin Valley as perennial grasslands, recent evidence suggests that most of this area was a desert vegetated by saltbrush scrub with sparse cover of native annual grasses and forbs. Many of the small vertebrates that evolved in these habitats, some of which are listed as threatened or endangered, are desert-adapted. These species evolved in sparsely vegetated habitats and rely on open ground to forage and avoid predation. Preliminary research indicates that populations of giant kangaroo rats (*Dipodomys ingens*), San Joaquin kangaroo rats *(D. nitratoides*), San Joaquin antelope squirrels (*Ammospermophilus nelsoni*), and blunt-nosed leopard lizards (*Gambelia sila*), all listed as threatened or endangered, are affected negatively by thick herbaceous cover. This cover also may adversely affect several listed plant species. Removing anthropogenic disturbances does not reduce or eliminate these exotic plants. Fire is effective in reducing herbaceous cover but kills native saltbrush and often is costly to implement or control. Although livestock may have contributed originally to habitat destruction and introduction of exotic plants, we believe that in some years, moderate to heavy grazing by livestock is the best way to decrease the dense cover created by exotics. Recent studies decisions to decrease or eliminate livestock grazing on conservation lands without definitive studies of grazing in these habitats may lead to further declines of native species and possible local extinction of some listed plants and animals.

Pyke, CR and J. Marty. 2005. Cattle grazing mediates climate change impacts on ephemeral wetlands. Conservation Biology 19:1619-1625.

Abstract
Climate change impacts depend in large part on land-management decisions; interactions between global changes and local resource management, however, rarely have been quantified. We used a combination of experimental manipulations and simulation modeling to investigate the effects of interactions between cattle grazing and regional climate change on vernal pool communities. Data from a grazing exclosure study indicated that 3 years after the removal of grazing, ungrazed vernal pools dried an average of 50 days per year earlier than grazed control pools. Modeling showed that

regional climate change could also alter vernal pool hydrology. Increased temperatures and winter precipitation were predicted to increase periods of inundation. We evaluated the ecological implications of interactions between grazing and climate change for branchiopods and the California tiger salamander (*Ambystoma californiense*) at four sites spanning a latitudinal climate gradient. Grazing played an important role in maintaining the suitability of vernal pool hydrological conditions for fairy shrimp and salamander reproduction. The ecological importance of the interaction varied nonlinearly across the region. Our results show that grazing can confound hydrologic changes driven by climate change and play a critical role in maintaining the hydrologic suitability of vernal pools for endangered aquatic invertebrates and amphibians. These observations suggest an important limitation of impact assessments of climate change based on experiments in unmanaged ecosystems. The biophysical impacts of land management may be critical for understanding the vulnerability of ecological systems to climate change.

Russell W. H., and J.R. McBride. 2003. Landscape scale vegetation-type conversion and fire hazard in the San Francisco bay area open spaces. Landscape and Urban Planning. 64: 201-208.

Abstract
Successional pressures resulting from fire suppression and reduced grazing have resulted in vegetation-type conversion in the open spaces surrounding the urbanized areas of the San Francisco bay area. Coverage of various vegetation types were sampled on seven sites using a chronosequence of remote images in order to measure change over time. Results suggest a significant conversion of grassland to shrubland dominated by *Baccharis pilularis*on five of the seven sites sampled. An increase in *Pseudotsuga menziesii* coverage was also measured on the sites where it was present. Increases fuel and fire hazard were determined through field sampling and use of the FARSITE fire area simulator. A significant increase in biomass resulting from succession of grass-dominated to shrub-dominated communities was evident. In addition, results from the FARSITE simulations indicated significantly higher fire-line intensity, and flame length associated with shrublands over all other vegetation types sampled. These results indicate that the replacement of grass dominated with shrub-dominated landscapes has increased the probability of high intensity fires.

Dahlgren, R.A. et al. 2001. Watershed research examines rangeland management effects on water quality. California Agriculture 55:6:64-71.

Adapted summary
Vegetation affects the hydrologic cycle through evapotranspiration and the interception of water. Both processes are a direct function of the type and density of vegetation present in the watershed. On one hand native vegetation in California is being lost due to housing development, conversion to agricultural crops, sudden oak death syndrome and the death of oaks from wildfire. On the other hand, undistributed grasslands are reverting

to woody vegetation. What do these changes in vegetation type and density mean in terms of watershed function?

Beginning in the early 1950s, a series of watershed studies was undertaken on experimental watersheds at the Hopland Research and Extension Center in Mendocino County. The watersheds ranged from 30 to 210 acres. All have relatively steep slopes, from 20 to 60%. In 1956 vegetation from Watershed I was mechanically removed, followed by burning of woody materials, treatment of stumps with herbicide and seeding with a grass-legume mixture. Between 1960 and 1965 vegetation in Watershed II was killed with herbicide. Dead trees were left in place. In 1965, Watershed II was burned and reseeded with a grass-legume mixture. Vegetation, stream flow and sediment data were collected from both Watershed I and II for over a decade following vegetation conversion on each watershed.

The researchers found that after conversion to grass vegetation, peak runoff rates were reduced by about 25% compared to pretreatment storms; however, the period of runoff was extended resulting in intermittent streams becoming perennial. Researchers found that reduced peak flows resulted from an increase in grass cover that retarded overland flow and permitted more opportunities for infiltration. These also noted that the long-term increase in runoff and an extension of base flow through the dry season resulted from the removal of the deep-rooted trees. These results are different from that realized in other studies conducted in other woodland and forest systems elsewhere in the world.

Preliminary data from a new series of watershed studies initiated at Hopland in 1998 indicate that livestock grazing does not significantly increase nutrient and sediment levels in stream water, but that current fecal coliform standards may be exceeded during storm events.

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Allen- Diaz, B. et al.2004. Long-term grazing study in spring-fed wetlands reveals management tradeoffs. California Agriculture 58 (3): 144-143.

Abstract

Spring-fed wetlands perform many important functions within oak-woodland landscapes, and livestock grazing modifies these functions. We used 10-year (long-term) and 3-year (paired-plot) experiments to better understand grazing management effects. We studied spring ecosystem responses in plant composition, diversity and cover; channel morphology; water quality; aquatic insects; and greenhouse gases. Lightly and moderately grazed wetlands exhibited lower insect family richness than ungrazed springs. Plant cover was maintained for the first 7 years of grazing, and plant diversity was not significantly affected. Likewise, the removal of grazing decreased emissions of methane, a greenhouse gas, but increased levels of polluting nitrates in spring waters, highlighting the complex management tradeoffs inherent to cattle grazing in wetland areas. In general, light cattle grazing at springs appears to be desirable from an ecosystem function perspective.