A Review of Ecological Grazing Management Approaches Applicable to EBRPD Rangelands

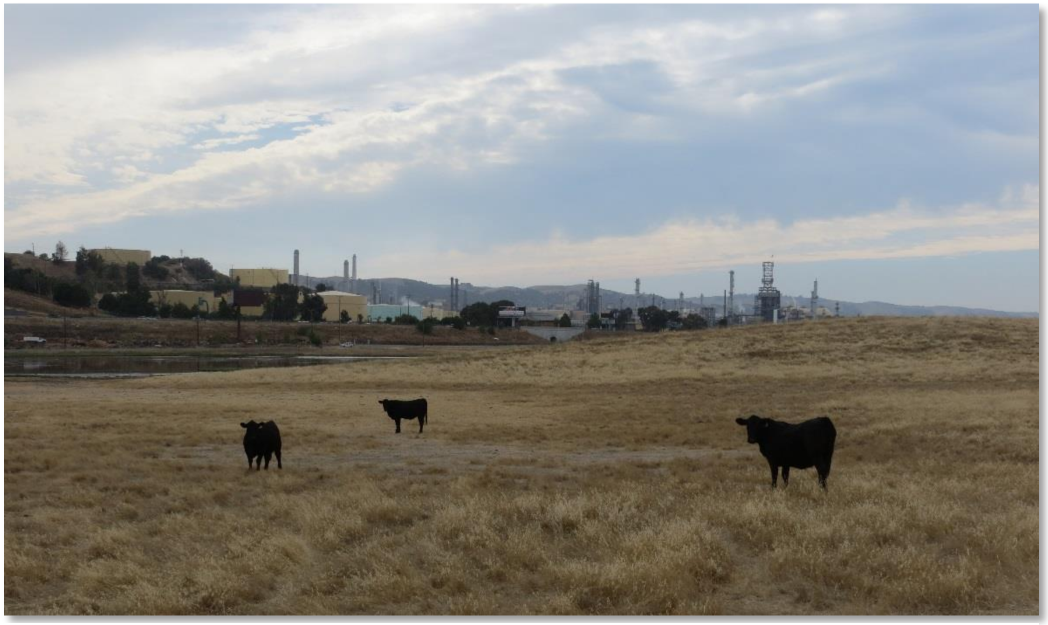
Figure 1. Beef cattle at Waterbird Park (Courtesy of the author)

The East Bay Regional Parks District (District) manages over 78,000 grazed acres in Contra Costa and Alameda Counties[1]. Thoughtful management of these grazed landscapes is important for maintaining biological, cultural and scenic values that are core to the District mission statement[2]. ***Grazing on District lands supports biodiversity, fire hazard reduction goals, management of invasive species, and maintenance or creation of sensitive wildlife and plant habitat[2,3].*** However, grazing can have drawbacks that depend on the timing, intensity and distribution of livestock use when applied to a given park with unique social, biological and geomorphic characteristics. The ability to integrate flexible, adaptive management approaches based on sound science allows managers to optimize the benefits while minimizing the drawbacks of livestock grazing across the ever-changing and expanding District lands[3,4].

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BACKGROUND

District rangelands include woodlands, shrublands, grasslands and other less common range ecosystems[5]. These various types of rangelands create a mosaic of land cover types that vary according to climate, geomorphologic and management factors[6]. The primary forage for grazing animals comes from the District grasslands: interior annual grasslands, coastal prairie remnants, and coast range grasslands[7]. These grasslands are largely dominated by non-native annual grasses that were introduced from the Mediterranean Basin and have become naturalized throughout California[8]. The true botanical composition of pre-European grasslands are not fully understood, although some combination of native perennial bunchgrasses, rhizomatous grasses, various forbs, and wetland plants likely covered much of the now non-native annual grasslands[9].

The combination of intensive farming practices, historical heavy stocking rates, drought, and introduction of non-native plant species that were pre-adapted to the climate and disturbances allowed for the large-scale conversion from a native grassland community to a largely introduced one with patches of native diversity [10–12]. In more recent years, fire suppression and removal of livestock have caused conversion of grasslands to highly flammable shrub stands[13–16].

Woodlands and shrublands provide lower levels of forage for livestock and are thus less heavily used. Minor rangeland types include serpentine substrates, alkali or halophytic scalds, high clay deposits, riparian areas, and isolated wetlands. These rangelands disproportionately contribute to the native plant diversity of rangelands due to their unique hydrologic and edaphic features, including low nutrient or chemically inhospitable soil types [17,18]. These unique rangeland types often occur within grasslands on District lands and host various federal and state listed plant species, as well as many locally rare species.

Management of these East Bay rangelands has been occurring since humans entered the landscape 13,000 to 11,500 years ago[19]. Native American communities and later Western settlers manipulated the landscape with burning, livestock grazing, manual removal of some plant species and propagation of favored plants[20,21]. The establishment of the District and other public utility districts in the early 1900s marked a transition from privately owned grazed lands to a matrix of public and privately-owned lands[22–25].

WHAT IS A RANGELAND?

California rangelands consist of the land cover types that can be utilized by livestock where environmental factors limit potential cultivation or forestry[5]. California hosts a wide variety of rangelands, including woodlands, shrublands, and grasslands. This paper focuses on the dominant Mediterranean grassland communities of California: interior annual grassland, coastal prairie grassland, and coast range grassland[7]. The composition and productivity of these grasslands are subject to control by climate, edaphic and topographic factors on many temporal and spatial scales[3,5,7]. The two major grassland types, interior annual grassland and coastal prairie grassland are distinguished by their regional geographic and climatic factors, with the coast range grassland exhibiting intermediate factors and consequently intermediate species composition[7].

This transition has made public landowners key players in maintaining the East Bay ranching community as livestock operators have become increasingly dependent on public lands leases in order to keep their operations viable[23,24]. The majority of EBRPD leases are held by cattle operators with cow-calf or stocker herds that are seasonally or continuously grazed[1], while a few leases are held by sheep ranchers for seasonal grazing. Continuous grazing is preferred for non-equilibrium systems to allow cattle to select forage[21]. However, land managers may prefer to have seasonal grazing, which maintains higher levels of residual dry matter[1], in order to preserve aesthetics, provide a cattle-free recreation experience, or target special resources.

> "THE EBRPD LEASES ITS LAND TO LOCAL AREA RANCHERS WHO USE PARK FORAGE RESOURCES TO SUPPLEMENT THEIR OVERALL LIVESTOCK GRAZING OPERATIONS. THE ANIMALS UTILIZE THE PRODUCTIVE FORAGE AS A RENEWABLE RESOURCE THAT WOULD OTHERWISE GO TO WASTE AND ACCUMULATE TO THE DETRIMENT OF THE LAND AND WILDLIFE."
>
> Budzinski 2005

The management of grazing operations on District lands is guided by the Wildland Management Policies and Guidelines and the Procedural Manual, which dictate the specifics of grazing leases, range assessments, and monitoring requirements[26,27]. These policies have been informed by management response to litigation and controversy over grazing on District wildlands. General concern over grazing practices rose to its height in the 1990's, with primary concerns for potential loss of native biodiversity, potential for increased erosion and degradation of water quality. In response to these concerns, the District gathered a task force to review such issues and provide recommendations for improved management. Following this period of heightened controversy over public lands grazing, the scientific community and local rangeland coalitions have demonstrated the major benefits and tradeoffs conferred by livestock grazing to rangeland ecosystems[28]. This report summarizes the results from scientific inquiry that apply to grazing on East Bay rangelands.

FIRE HAZARD REDUCTION

District lands often span the wildland-urban interface and are subject to increased ignition sources and increased potential for damage to homes and human populations[29]. Fire hazard reduction is a major concern for East Bay communities, which have had a history of catastrophic fires in Oakland and Berkeley[24]. ***Grazing of arid landscapes at high densities can drastically reduce or eliminate fire hazards by changing the vegetation's fuel structure, moisture and continuity***[30–32].

The East Bay's grazed, or previously grazed, landscapes are characterized by a mosaic of non-native grasses and the native shrub, coyote brush (*Baccharis pilularis*) [33]. Reduction or removal of grazing increases the length of the fire season in spring and increases fire frequency by increasing the highly flammable shrublands[13,34,35]. Effective, continuous livestock grazing of District rangelands maintains lower shrub cover relative to grass which in turn reduces fire intensity, flame length and risk of fire[33]. However, the biomass of the non-native grass component must also be reduced in order to decrease the probability of ignition, continuity of fuels and length of fire season[36,37]. Short-duration or insufficient seasonal grazing may not reduce non-native grass biomass sufficiently to reduce fire hazards[34].

GRAZING REPRESENTS THE MOST COST-EFFICIENT AND EFFECTIVE METHOD OF LANDSCAPE-SCALE FIRE HAZARD REDUCTION ACKNOWLEDGED BY LOCAL FIRE CHIEFS[20,34].

Commercial goat and sheep operations have been increasingly utilized for hazardous fuel reduction in high risk areas along the urban development fringe[38–41]. While expensive, this treatment is effective at reducing woody vegetation that is underutilized by or inaccessible to cattle. Specific benefits to using these operations include: general public support, ability to optimize grazing treatment timing and intensity and optimizing the selectivity of livestock[41,42]. In order to protect sensitive resources, targeted grazing is prohibited in sensitive plant communities like maritime chapparal[43].

INVASIVE SPECIES MANAGEMENT

Livestock grazing in California has a complex relationship with non-native and invasive plant species: from having a role in initial seed introduction and dispersal throughout the state to the ability to reduce the cover and negative impacts of highly invasive species[10,44,45]. Two major classes of non-native and invasive plant species exist within the District:

1. a naturalized, dominant community of non-native grasses and forbs that dominate the interior annual and coast range grasslands; and
2. later-introduced problematic grassland invaders that are targeted for reduction or removal due to their negative effects on ecosystems, plants and wildlife communities, as well as livestock health[35].

Figure 2. Milk thistle in annual grassland (Courtesy of the author)

As mentioned earlier, the non-native annual grass species that dominate the grasslands contribute to flammable biomass, and can be effectively reduced through extensive cattle or sheep grazing[46].

Noxious grasses, thistles and woody plant species are invading District rangelands. Targeted livestock grazing can reduce the cover and extent of many of these species through manipulations of the timing and intensity of grazing, and type of livestock used[41]. Unlike the extensive grazing that reduces palatable, naturalized annual grasses, targeted grazing requires additional time, knowledge, flexibility, and resources on behalf of the livestock operator and park staff. Careful grazing management is important in most cases because inappropriate timing, intensity or distribution of livestock can increase the cover of the targeted noxious weeds.

- **Medusahead** (*Elymus caput-medusae*), an unpalatable annual grass, has been reduced by repeated high intensity, short duration cattle or sheep grazing during key phenological stages[47–53].
- Another novel unpalatable grass, **barbed goat grass** (*Aegilops triuncialis*), can be reduced with timed high-intensity cattle or sheep grazing in combination with herbicide treatment[54,55].
- Timed grazing of cattle, sheep and goats reduced **yellow starthistle** (*Centaurea solstitialis*) before the spiny stage[56–58].
- Other **thistles**, such as bull thistle (*Cirsium vulgare*), can be reduced with early, heavy, and repeated cattle, goat or sheep grazing[41,59].
- Other **forbs and woody plants** that are often toxic or unpalatable to cattle can be reduced by goat or sheep grazing[41].

LIVESTOCK GRAZING IS THE MOST EFFECTIVE, ECONOMICAL TOOL TO MAINTAIN SENSITIVE WILDLIFE AND PLANT HABITAT OVER LARGE AREAS[61].

WILDLIFE HABITAT

The widespread conversion of fertile, easily developable valleys and floodplains in the Bay Area has shifted or isolated the distributions of endemic wildlife species to undeveloped landscapes, including District rangelands[60]. These grazed lands host a wide variety of native wildlife, including federal or state listed species such as the California tiger salamander (*Ambystoma californiense*), California red-legged frog (*Rana draytonii*), Alameda striped racer (*Coluber lateralis euryxanthus*), golden eagle (*Aquila chrysaetos*), burrowing owl (*Athene cunicularia*) and other grassland birds. For many of these grassland-associated species, livestock grazing maintains or creates optimal features of their required habitat.

DECIPHERING LISTING STATUS ACRONYMS: PART I

USFWS= U.S. FISH AND WILDLIFE SERVICE, FEDERAL LISTING AGENCY

CDFW= CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, STATE LISTING AGENCY

FE= FEDERALLY ENDANGERED (USFWS)

FT = FEDERALLY THREATENED (USFWS)

SE- STATE ENDANGERED (CDFW)

ST- STATE THREATENED (CDFW)

SSS = STATE SPECIES OF SPECIAL CONCERN (CDFW)

SFP = STATE FULLY PROTECTED (CDFW)

HERPETOFAUNA: Reptiles and Amphibians

Grazing land is considered the basic habitat type for **California tiger salamander** (CTS; FT & ST), a federally and state threatened species in central California [61]. Excluding sandstone vernal pools, CTS are found exclusively in ponds and adjoining uplands grazed by livestock at EBRPD[62]. Livestock pond establishment and maintenance has created and replaced natural CTS habitat that was lost to urban, industrial, and agricultural development[62–64]. Although the 5-year status review of CTS acknowledged the concern for potential CTS take from livestock trampling, the review concludes that the benefits from heavy grazing outweigh this potential[65].

California red-legged frogs (CRLF; FT) are found in a mosaic of vegetation communities with access to open water for rearing habitat[64]. Similar to the CTS 5-year status review, the CRLF Recovery Plan states that livestock both degrade and create CRLF habitat and that stock ponds are important created habitat[66]. The Critical Habitat Final Rule recommends managed routine grazing for habitat maintenance while avoiding detrimental effects from overgrazing[67].

Alameda striped racers (ST & FT) preferentially select areas with a mosaic of grass and shrub cover that host key prey species, such as fence lizards, which are observed more often in grazed sites[68–70]. The 5-year Review and Recovery Plan cite both inappropriate grazing and removal of grazing as threats. Furthermore, the reports found that cattle grazing is important in reducing tall herbaceous material and creating habitat for key prey species[71,72].

Cattle grazing is an important tool in maintaining critical habitat features for each of these listed herpetofauna. While there is a small potential for direct take of animals from routine grazing, the removal of grazing would significantly alter the preferred habitat for these species. ***The U.S. Fish and Wildlife Service documents reflect a changing perspective on grazing and wildlife habitat, increasingly acknowledging the importance of livestock operations in critical habitat creation.*** Historic and current cattle operations are responsible for the creation and maintenance of ponds and the upland grassland mosaic habitat that are critical to CTS, CRLF and Alameda striped racer success in the East Bay.

East County Wildlife

Livestock grazing of District rangelands creates habitat for sensitive grassland-associated species by increasing bare ground, reducing vegetation height and decreasing plant biomass[73]. Sensitive San Joaquin Valley species, such as grassland birds and listed mammals, generally prefer low residual dry matter and low stubble height found with heavier grazing regimes[74,75].

Figure 3. Horned lark nest in heavily grazed cattle pasture (courtesy of the author)

Grassland-associated birds benefit from livestock grazing for maintenance of nesting, foraging, dispersal, and rearing habitat. Both the **prairie falcon** (*Falco mexicanus;* delisted SE & FE) and **Swainson's hawk** (*Buteo swainsoni;* ST) make heavy use of grazed grasslands[76–80]. **Horned larks** (*Eremophila alpestris*) specifically selected livestock-grazed sites in a local study of grassland birds in District parks[81,82]. The bare ground and low vegetation created with moderate grazing was found to be positive for **burrowing owl** (SSS) individuals[83]. Interestingly, burrowing owls that used cattle dung to line nests had increased likelihood of survival[84].

Mammals associated with San Joaquin annual grasslands are dependent upon livestock to increase bare ground patches, reduce vegetation height and remove litter. Grazed landscapes are the preferred habitat for **San Joaquin kit fox** (*Vulpes macrotis;* ST & FE)[85–87]. Northern populations of kit fox depend on ground squirrel populations that are maintained by grazing[88]. **Kangaroo rats** (e.g. *Dipodomys heermani*) are also positively associated with livestock grazing and reduced grass stature[89,90]. **Ground squirrels** (e.g. *Spermophilus beechyi*) and other small mammals are important as food source for raptors, including the listed **golden eagle** (SFP), and as ecosystem engineers creating a tunnel network used by rare amphibians. Gophers (e.g *Thomomys bottae*), voles (e.g. *Microtus californicus*) and ground squirrels have been found preferentially in grazed grasslands with low stature vegetation[10,61,91,92]. At Vasco Caves Regional Preserve, ground squirrel burrow complexes decreased the most in grazing exclusion plots[93].

How do livestock help native plant species and communities?

The dramatic conversion of the native flora to non-native annual grasses has created a novel system that is most effectively managed with livestock. The type of livestock can be specified to restore the native plant community or species of concern: cattle select for non-native grasses over native forbs; sheep are more flexible but generally select more forbs, leaving native grasses; and goats select for woody material[41]. These natural preferences can help managers maintain or improve habitat for plants that require lower residual biomass, greater levels of disturbance, more bare ground, and less competition with neighboring plants[28].

Cattle preferentially consume highly competitive non-native grasses, which increases the competitive advantage of native and rare forbs[28,41,114]. District rangelands are home to many rare plant communities, including serpentine prairies and alkali flats. "Around 90% of species listed in the Inventory of Rare and Endangered Species in California … inhabit California's grassland ecosystems."[9]. Although grazing was cited as a threat to rare plant recovery in many of the original listing documents, current summaries often acknowledge the beneficial aspects of grazing.

Cattle grazing is also important in maintaining required forb host plants for native and listed butterfly species. Prior to invasion by Mediterranean annual grasses, the Central Valley hosted forb-rich prairie landscapes that supported seven species of lepidoptera[94]. Specifically, the **Bay checkerspot butterfly** (*Euphydryas editha bayensis;* FT) habitat is improved on grazed serpentine grasslands[95]. The **Callippe Silverspot butterfly** (*Speyeria callippe callippe;* FE) and its host plant Johnny jump-up (*Viola pedunculata*) also benefit from cattle grazing that reduces the cover of shrub species, the competitive advantage of non-native grasses, and the amount of thatch buildup[96,97].

NATIVE PLANTS AND COMMUNITIES

Native grasslands

Native grasses show variable results with grazing depending on the grass species, the type of livestock, and the management approach. District grasslands included in a 10-year study showed a trend of higher native plant diversity in livestock grazed areas[4]. Applying short duration, high intensity sheep or cattle grazing in spring was found to benefit native grasses, particularly in coastal-influenced climates[98,99]. A dominant native grass in coastal prairie systems, **California oatgrass** (*Danthonia californica*), responded positively to both grazing and grazing removal[100,101]. A significant native grass component in more inland grasslands, **purple needlegrass** (*Stipa pulchra*), is resilient and adapted to grazing[102]. However, the long and short term effects of grazing on needlegrass interacted with fire, environmental variables and the specifics of the grazing approach[103]. One study demonstrated that needlegrass stands have increased under spring grazing; while in another, the individual plants were smaller on grazed pastures[102,104]. In another study, grazing enhanced juvenile and seedling survivorship[105]. Other studies found cattle grazing reduced the height and reproductive output of needlegrass, and recommended protecting seedling restoration from cattle[106,107]. Still others found no effect from grazing and that previous cultivation was more important[10,46].

Rare Plants

The **Presidio clarkia** (*Clarkia franciscana*; FE/SE/CNPS 1B.1) is found in serpentine prairies in the Bay Area[108]. In the District's serpentine prairie at Redwood Park, cessation of grazing was considered a major factor in loss of clarkia habitat[109]. Researchers have also recommended increasing grazing trials in clarkia habitat to increase disturbance and decrease cover of non-native annual grasses[110]. Grazing of serpentine prairies reduces the negative effects of nitrogen deposition from anthropogenic sources (e.g. car exhaust) by removing increased non-native grass biomass and allowing serpentine endemic species to compete[95,111].

DECIPHERING LISTING STATUS ACRONYMS: PART II

CNPS = CALIFORNIA NATIVE PLANT SOCIETY

1B = PLANTS RARE, THREATENED, OR ENDANGERED IN CALIFORNIA AND ELSEWHERE

0.1-SERIOUSLY THREATENED IN CALIFORNIA

0.2-MODERATELY THREATENED IN CALIFORNIA

San Joaquin saltbush (*Extriplex joaquinana*; CNPS 1B.2) is found in alkali seasonal wetland habitats[108]. Although the East Contra Costa Habitat Conservation Plan (ECCHCP) cited overgrazing as a threat[112], the cover of native vegetation in natural vernal pools decreases with competitive exotic annual grasses in upland and shallow pool regions[113,114]. Additional research could improve the understanding of grazing effects on this species.

Big plumose tarplant (*Blepharizonia plumosa*; CNPS 1B.1) is found in grazed annual grasslands with clay substrates[108]. The ECCHCP cited ground disturbance and erosion from cattle as a possible threat[112]. However, the California Natural Diversity Database and major studies do not consider grazing a threat and instead consider invasive plant competition to be a major concern[108]. Studies found that other environmental factors such as patchiness of burns and amount of precipitation were more significant in determining population dynamics[115–117].

BEST MANAGEMENT FOR WETLANDS

Concerns regarding livestock use of wetland areas include physical alteration of the wetland, introduction of plant seeds, nitrogen loading of the water body and herbivory of vegetation[135]. These impacts can be ameliorated by using best management practices, such as providing off-stream water and shade, creating armored crossings, and in special cases, fencing riparian pastures. Creating pastures that include wetlands allows managers to manipulate the season of use, target grazing of weedy species, and create recovery periods. Maintaining light to moderate grazing levels also reduces negative impacts to riparian vegetation, maintain bank stability and maximize spring ecological function. Additionally, both the American Fisheries Society and the Wildlife Society do not recommend removing livestock grazing from riparian areas, and fencing of stock ponds can even be detrimental to CTS[64, 135-140].

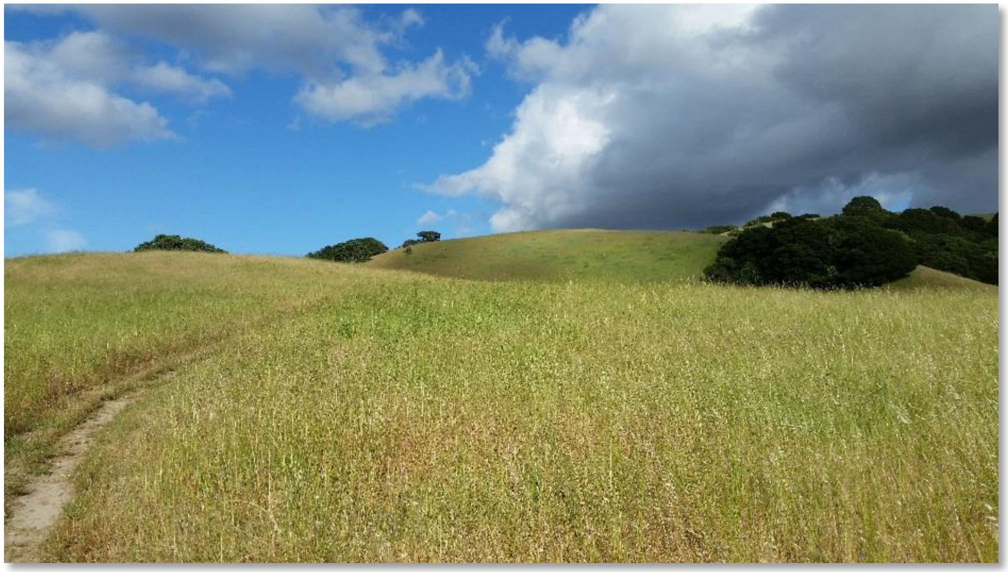
Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii* FE/SE/CNPS 1B.1) occurs on sandy bluffs and dunes[108]. In this case, grazing was not listed as an initial threat, although invasive species were considered a significant concern[118]. One field study used grazing treatments for removing invasive species at the Antioch Dunes National Wildlife Refuge. In general, grazing is recommended for removing residual dry matter, reducing fire fuels, and reducing cover of invasive species[119].

Santa Cruz tarplant (*Holocarpha macradenia* FT/SE/CNPS 1B.1) is found on clay or sandy dry substrates in coastal prairie, scrub and annual grasslands[108]. While the original listing cited grazing as a threat, the current review considers light to moderate grazing beneficial. "Grazing likely improves habitat quality for *H. macradenia* by removing plant biomass cover, reducing aboveground competition during the growing season, and reducing thatch accumulations that inhibit tarplant germination. Additionally, trampling by grazers can open, roughen, and compact surface layers of soil"[120]. Grazing also increased seed germination and production in experimental seeding of the plant[121–123]. Disturbance is considered an important factor in the success of the species[124].

Large-flowered fiddleneck (*Amsinckia grandiflora* FE/SE/CNPS 1B.1) is found in annual grasslands and woodlands[108]. The fiddleneck is simultaneously considered threatened by overgrazing and benefited by carefully managed grazing[125]. Furthermore, removal of cattle grazing allowed for decimation of the population by rodents. More recent research and observation has also shown that complex interactions exist between grazing management and precipitation[126].

MANAGEMENT RECOMMENDATIONS

Both the benefits and drawbacks of grazing exist in a spatially and temporally heterogeneous environment that calls for site-specific recommendations with flexibility[4,127]. In order to maximize the ecological benefit of livestock grazing, resource managers and livestock operators can first assess baseline conditions, monitor for success criteria or indicators of resource health, revisit the status of those indicators and change management as necessary. Managers can also maximize benefits by incorporating new approaches to determining site potential for targeting management within highly variable non-equilibrium landscapes before deciding on approach[128].



CONCLUSION

Livestock grazing is an effective management tool for reducing fire fuels, targeting invasive species, maintaining biodiversity, and creating and maintaining native wildlife and plant habitat. Managed grazing is sometimes associated with tradeoffs between targeted resources, where one may see result in benefits while another may be detrimental. Changing perspectives on livestock grazing can lead to ambiguity and internal contradiction within documents that summarize threats and benefits to sensitive resources. Flexible planning, science-based monitoring and adaptive management with clear goals can help address issues that arise[129].

FUTURE RESEARCH

Additional studies that incorporate site- and species-specific research would help to better understand effects of specific grazing activities.

- How does livestock play a role in climate change? Are the global estimation of livestock greenhouse gas emissions correctly estimated for developed countries[130]?
- There is overall optimism for rangelands in the carbon market that should be further analyzed[131]. What is the potential for carbon sequestration on non-equilibrium grazed lands through enhancement or preservation[132]?
- Further research could better quantify improved water yield in wetlands within grazed landscapes[133,134].

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