

## **Compatibility of livestock grazing and recreational use on coastal California public lands: Importance, interactions, and management solutions**

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### **Abstract**

While the primary use of rangelands for well over a century has been livestock grazing to produce food and fiber, elevated demand for recreational land has increasingly brought livestock-recreation interactions to the forefront. California's Central Coast is a hotspot for graziers and recreationists alike and provides an important region in which to address the challenges and synergies of concurrent grazing and recreation. Here we review the literature to elucidate the impetus for livestock grazing on publicly-owned recreational lands, discuss potential areas of conflict, and highlight promising avenues for fostering positive livestock-recreation interactions. Managers grazing livestock on public lands have adopted a variety of management practices to minimize conflicts and maximize benefits derived from multiple uses of public lands. Graziers are interested in supporting environmental health and protecting ecosystem services provided by rangelands, and grazing practices have improved over time to the point that well-managed grazing can enhance recreational lands and improve wildlife habitat. However, even a few perceived negative recreationist experiences may prompt some public land agencies to remove livestock grazing entirely. Conflicts between recreationists and ranchers could be minimized and benefits maximized with appropriate policies and creative management. Moreover, California's grasslands are the most "at risk" habitat type for development, and increasing economic and social pressures on ranchers that utilize leased public lands make it more likely that ranchers will sell their private lands to developers if access to public grazing land was eliminated, further increasing threats to our already dwindling rangelands. The continued accessibility of public lands for grazing is thus inextricably linked to the protection of private rangelands and the critical resources they provide. Novel approaches to public education and collaborative land management are critical to reducing negative livestock-recreation encounter and ensure continued conservation of wildlands.

### **Keywords**

Conservation, grassland, grazing, land-use conflicts, rangeland, recreation

## Introduction

Over 700 million acres (300 million ha) of public and private rangelands in the U.S. support a host of activities, including livestock grazing and recreation, and provide a plethora of ecosystem services necessary to sustain human and wildlife populations (see reviews by Foley, 2005; Havstad et al., 2007; Millennium Ecosystem Assessment Program, 2003). In California alone, 30% of public land is rangeland, covering over 32 million acres (13 million ha) (Fire and Resource Assessment Program, 2010). As populations and demand for resources increase on an otherwise finite land base, interactions and conflicts between multiple uses inevitably result. While the primary use of rangelands for well over a century has been livestock grazing to produce food and fiber, an elevated interest in and demand for recreational areas has increasingly brought livestock-recreation interactions to the forefront. Competition for the services derived from these natural ecosystems will continue to increase (Forest Service, 2012).

California's Central Coast is a hotspot for graziers and recreationists alike, and thus an important region in which to address the challenges and synergies of concurrent grazing and recreation (Hayes and Holl, 2003). Limitations on suitable land for recreation constrains recreational demand and often puts recreationists at odds with graziers, who also face increased constraints on the amount of land available for grazing, economic costs associated with grazing on a limited land base (Resnik et al., 2006), and reduced forage and water resources due to climate change and long-term droughts (Bureau of Land Management, 2009; Forest Service, 2012; Holland, 2015). Water shortages in the U.S. are highest, and projected to get substantially worse, in California, where there already exists increasing pressure on graziers to secure land with reliable water sources. Access to grazing land, especially on the Central Coast is becoming more limited not only due to conversion to residential and agricultural uses, but also to public open space. Although grazing remains a management tool on some open spaces, livestock numbers may be reduced, and in some cases grazing may be entirely removed (Forest Service, 2012; Holland, 2015; McGall, 2015). Demands for recreational lands are expected to simultaneously increase. Therefore, as grazing moves beyond previously privately-owned open rangelands onto public lands, encounters between livestock and recreationists are likely to increase (Forest Service, 2012). However, while grazing and recreational uses of land may at times be at odds, these uses may also be compatible, and even mutually beneficial.

We conducted a review of the literature to elucidate the impetus for livestock grazing on publicly-owned recreational lands, discuss potential areas of conflict, and highlight promising avenues for fostering positive livestock-recreation interactions. We discuss a variety of practices that managers have adopted to minimize conflicts and maximize benefits derived from multiple uses of public lands, although we have focused on concerns that are locally relevant to the central and northern coasts and coastal ranges of California. For the purposes of this review, we define "livestock-recreation interactions" as **encounters between** livestock and/or the effects of livestock grazing **and** recreationists and/or the effects of recreation (including companion animals under the control of recreationists). Throughout this review, we refer to "grazing in recreational areas", or the like, to describe the relationship between livestock grazing and recreation, but this could equally be expressed as "recreation on grazing lands". We also conducted interviews and surveys of public lands' managers, and refer to these currently unpublished data throughout this review (Wolf et al., unpublished results).

***Brief History of Grazing on Public and Private Lands in the U.S.***

Prior to restrictions on livestock grazing, free forage on western rangelands attracted pioneering graziers, and a first come-first serve approach to grazing management (Bureau of Land Management, 2009) resulted in sometimes bloody range wars (see review by Fredrickson et al., 1998). The Homestead, Preemption, Timber Culture, and Desert Land laws theoretically limited livestock grazing, but loopholes and frequent fraud reduced their regulatory effectiveness. Livestock numbers increased on public lands from 1870 to 1900 from 4.1 million to 19.6 million beef cattle, and 4.8 million to 25.1 million sheep, resulting in major degradation of rangelands. The Taylor Grazing Act of 1934 resulted in a reduction in the number of livestock operations and animal numbers, as graziers were required to obtain and pay for grazing permits on public lands, a portion of which were put toward “range improvements” (Bureau of Land Management, 2009).

The Federal Land Policy and Management Act (FLPMA) of 1976 brought even more scrutiny to public lands grazing as social and ecological values and disputes over conflicting uses arose. Environmental concern has increased over time (Dunlap, 1991) and rangeland management has come under stronger scrutiny even as grazing practices improve. However, the general public has little access to clear information for understanding grazing management and rangeland conditions (Dunlap, 2014). Policy development tends to be reactive, and restrictions frequently result in increased control over grazing and rising costs for producers as more intense herding management, water development, exclusion from riparian areas, and fencing are required (Bureau of Land Management, 2009). The Public Rangelands Improvement Act of 1978 went beyond FLPMA to focus specifically on all rangelands (not just public rangelands) in response to perceived continued range degradation and negative impacts on multiple ecosystem services, as well as to public pressure regarding removal of livestock from public lands (Bureau of Land Management, 1994). This ultimately resulted in a shift from maximal exploitation to a reduction or exclusion of livestock grazing – in terms of both area grazed and stocking rates – and increased societal valuation of wildlife and recreation (Fleischner, 1994).

As populations and environmental pressure have increased, the need to enhance and benefit from multiple ecosystem services has led to managing for trade-offs and concurrent multiple uses on rangelands (Forest Service, 2012; Herrero and Thornton, 2013). According to the Bureau of Land Management (2009), “...changing social values and competition for land use have required that public land management decisions achieve greater balance among sometimes conflicting resource uses.” While rangelands have historically been used largely for livestock grazing, public demand for, and allocation of open spaces to, recreational purposes have increased, and livestock-recreation conflicts have subsequently increased (Barry, 2014; Brown and Harris, 1992; Fleischner, 1994; Forest Service, 2012). A shift from a focus on the negative effects of grazing management, to instead a greater concern for the loss of total land area, underlies our increasing understanding that the “all-or-nothing” approach to land management can have deleterious effects on rangeland health and biodiversity (Brown and McDonald, 1995) to the same or even greater magnitude than poorly managed grazing might. For at least six decades, researchers, naturalists, and range managers have increasingly and explicitly recognized that increased demand for recreational land would increase pressure on grazing lands (Bureau of Land Management, 2009, 1994; Dutton, 1953; Fulbright and Ortega-Santos, 2006; Havstad et al., 2007; Landstrom, 1965; Menke and Bradford, 1992; Veblen et al., 2014; Wilkinson, 1992). The number of peer-reviewed journal articles referencing “recreation” and “livestock” was low prior to 1990, but has increased slowly and steadily since.

***Current Trends in Livestock Grazing, Recreation, and Their Interaction on Public Lands***

Recreation has increased in the U.S. over time: the total number of recreationists increased 7% from 2000 to 2009, and the number of recreation days increased by 30%. Over the next 45 years, activities including off-road vehicle use, hunting, and fishing are projected to decline, while nature viewing is projected to increase by over 100 million people (Bowker et al., 2012; Forest Service, 2012). While demands for recreational lands are expected to increase, little increased grazing pressure (no increase in number of livestock) is expected in the foreseeable future. However, graziers continue to operate under increasing constraints and a shrinking private land base, and need to graze the same number of animals to remain economically viable. While public land holdings are increasing on the Central Coast, private land holdings are decreasing as previously contiguous, large tracts of land are fragmented and developed, and rangelands in areas with abundant agriculture are converted to crops (Forest Service, 2012; Holland, 2015). Increasing pressures on ranchers in the Central Coast make it more likely that ranchers will sell their private lands to developers or public entities, further increasing threats to our already dwindling rangelands. In fact, ranchers in Alameda and Contra Costa counties with public land grazing leases estimated that over 40% of their ranch income came from public land leases (Sulak and Huntsinger, 2007). The presence of large well-managed tracts of grazed land helps protect these lands from development, but grazing operations must also be financially viable as well, and limiting grazing to small tracts of private land may preclude this. Moreover, maintaining rangelands as ungrazed wildlands for aesthetic values alone will not save them from development. However, economic sustainability of operations conducted on these lands, which may include well-managed grazing operations, could go far in protecting them (Fire and Resource Assessment Program, 2010). The continued accessibility of public lands to grazing is therefore inextricably linked to the protection of rangelands and the critical resources they provide (Sulak and Huntsinger, 2007). Nonetheless, cattle-grazing on public lands has come under fire even more for the perceived and potential impacts on natural resource management and recreational pursuits (Eisenstein and Stampe, 2006; Tempest, 2004).

While land managers recognize more than ever that multiple land uses are often compatible and even desirable for more efficient use and better management of rangelands, multiple uses may result in net positive or negative outcomes for livestock grazing, recreational purposes, or environmental health, depending on the ecosystem service of interest (Nelson et al., 2010). Trade-offs depend on the focal resource, and the magnitude of their effects are spatiotemporally diverse and culturally context-dependent (Hayes and Holl, 2003; Herrero et al., 2009; Herrero and Thornton, 2013; Plieninger et al., 2012). For example, the Central Coast specifically has a mesic climate that produces a plant community that may respond differently to grazing than the interior of California, and in light of sweeping plant invasions across California, may require some degree of grazing disturbance to maintain native grasslands and reduce woody encroachment and exotic invasion (Callaway and Davis, 1993; Hayes and Holl, 2003).

Despite increased understanding of these regionally context-dependent outcomes, public opinion and policy generally change more slowly than scientific understanding of complex systems, with activism often preceding science (Noss, 1994). Couple this with resource managers who often have difficulty widely communicating the benefits of well-managed grazing for many ecosystems (Brunson, 1992), and the ultimate result has been a drop in livestock numbers in the U.S. over time, with a decrease in public land grazing and an increase in private land grazing. Cattle numbers peaked at about 130 million in the mid-1970's, and dropped steadily to around 90 million in 2015 (USDA NASS, 2015a); sheep numbered approximately 10

million head in 1994, dropping steadily to around 5 million in 2015 (USDA NASS, 2015b). As interest in conservation and understanding of grazing impacts on ecosystems increase within the ranching community, some private land graziers have sought public land grazing allotments to conserve their private land resource base. Alternatively, some have decreased herd size (Anderson, 1989; Barry and Amme, 2009; Sulak et al., 2008) when public land grazing leases were not available or difficult to obtain. Urban sprawl has also forced some ranchers to seek space on public lands (Tempest, 2004), and projections suggest further land development will occur at the expense of forests and rangelands, reducing not only total wildland acreage, but also the characteristics and function of remaining wildlands. California's grasslands are the most "at risk" habitat type for threat from development, followed by coastal scrub, montane hardwood, and blue oak woodland. Area covered by rangelands (including grasslands) in the U.S. decreased by 26 million ac (10.5 million ha) in the 25-year period from 1982 to 2007, and will continue to decline (Forest Service, 2012). In California 63% of rangelands are privately owned, and while this may give the impression that ranchers have plenty of land on which to graze, approximately 47,000 ac (19,000 ha) of California rangelands are converted to other uses *each year*. This leaves ranchers with a dwindling resource base, and frequently, the only sustainable environmental and financial option is to obtain a grazing lease on public land (Fire and Resource Assessment Program, 2010). However, concerns from the public and public land agencies may prevent increased public land grazing.

### **Potential Trade-Offs Associated with Livestock, Recreation, and Their Interaction**

Rangelands are an important conservation target (Plieninger et al., 2012) for the critical ecosystem services they impart (see review by Havstad et al., 2007), thus linking them uniquely to humans (Huntsinger and Hopkinson, 1996; Walker and Janssen, 2002). Rangelands are important for recreational (Huntsinger et al., 2007; Resnik et al., 2006) and educational opportunities (Havstad et al., 2007), cultural resources (land, ranching culture; see Brunson and Huntsinger, 2008; Huntsinger et al., 2007; Resnik et al., 2006), carbon sequestration and soil protection (Follett and Kimble, 2000), pollination services (Kremen et al., 2004), conservation and biodiversity values (Huntsinger et al., 2007; Resnik et al., 2006), and wildlife habitat (Huntsinger et al., 2007). Livestock grazing on rangelands also provides ecosystem services in the form of a marketable product such as food and fiber (Barry, 2014; Havstad et al., 2007), risk insurance and poverty reduction, particularly in developing countries (Hoddinott, 2006; Randolph et al., 2007), invasive and native plant management (Barry, 2011; Hayes and Holl, 2003; Ringgold, 2009), and fuels management and fire reduction (Havstad et al., 2007).

#### ***Benefits of livestock grazing for public lands management and recreation***

California's native plant community has undergone an unprecedented transformation to largely annual, non-native cover primarily due to invasion by Mediterranean grasses and forbs, resulting in sweeping changes to ecosystem processes, including changes to fire regimes (Mooney and Drake, 1986). Grazing is frequently supported by fire departments and other public organizations to reduce exotic annual grasses that may accumulate and pose a fire hazard, and may then impact surrounding structures (Fire and Resource Assessment Program, 2010), create bare soil (Ozaslan et al., 2015), and threaten native and sensitive plants (Menke, 1992) and wildlife (e.g., McCrary and Bloom, 1984). For example, the city of Walnut Creek, CA has

requested grazing on public lands to reduce fire risks; past fires have been blamed on a lack of cattle grazing since cattle were removed in 2010 due to public complaints. The city agreed to pay for goat grazing to reduce fuel loads and provide manual weed removal, but many citizens did not feel that this yielded a sufficient reduction in thatch accumulation, nor did they favor paying for grazing when cattle grazing leases could provide income to the city (Cuff and Nardi, 2013; Nardi, 2012). Alternatives for managing the land and vegetation without livestock are generally expensive, time consuming, and infeasible or unrealistic. For example, goat grazing may be less effective than cattle grazing at removing annual grass thatch layers, and the cost of leasing goats can be substantial (DiTomaso, 2000; Popay and Field, 1996). Mowing, while effective in reducing biomass and increasing native plant abundance and species richness (Maron and Jefferies, 2001), can carry a large carbon footprint and is infeasible on steep or rocky terrain (Bush et al., 2006). Herbicide applications, while often quite effective at least in the short-term, are expensive, can have negative impacts to the environment if used improperly, are not practical over large areas, and may not have public support (Holl et al., 2014). Prescribed burns are another option, but are difficult to conduct, have a risk of spreading to non-target areas, are often expensive to conduct, and are not reliable avenues for consistently removing excessive non-native plant materials year after year. The long-term effects of repeated burning on ecosystem processes, wildlife, and air quality are also unclear (Bush et al., 2006; Syphard et al., 2006).

Well-managed grazing may result in a host of other positive environmental outcomes as well (Briske et al., 2011). Grazing can be used as a tool to improve scenery and recreation in many cases. Exotic plant cover creates a large volume of decadent plant biomass, resulting in a resistant thatch layer that reduces light availability for small-statured native plants (Menke, 1992). These invasive plants can make passage through areas difficult, and may be painful or dangerous due to sharp stickers and thistles that can injure or kill wildlife and companion animals. Thatch is resistant to microbial breakdown and reduces enjoyment of scenery because it turns brown and grey over time, smothering growing plants and native wildflowers (Bush et al., 2006; Hayes and Holl, 2003). By removal of resistant non-native thatch layers with targeted grazing, recreationists can enjoy more comfortable and safer passage and potentially enhanced biodiversity of native plants and wildlife (Holland, 2015; Ringgold, 2009). Moreover, many native California grasses are well-adapted to grazing, having evolved over time to either tolerate or benefit from some level of grazing (Edwards, 1992). Finally, some recreationists appreciate the opportunity to see livestock grazing on the landscape (Barry, 2014; Holland, 2015; Wallace et al., 1996). Mixed livestock grazing and recreation may create opportunities for education while providing multiple economic, environmental, educational, and cultural services to local communities (Brunson and Steel, 1996; Resnik et al., 2006).

Anderson (1989) points out that removal of livestock grazing may also have substantially negative impacts on some wildlife populations. Private lands in California harbor a substantial proportion of our state's floral and faunal biodiversity (Hilty and Merenlender, 2003; Scott et al., 1995), and removal of grazing on public lands may concentrate cattle on private lands, further stressing a system already contending with the effects of weed invasion (DiTomaso, 2000; Mooney and Drake, 1986), periodic or long-term drought (Forest Service, 2012), and systematic, long-term fire suppression (D'Antonio and Vitousek, 1992). Moreover, higher quality regrowth from plants grazed early in the growing season may actually provide better forage for grazing wildlife. Livestock grazing can be manipulated in a manner to enhance wildlife forage, while leaving more than enough forage for wild grazing animals. Some threatened and endangered species require low vegetation heights that can result from grazing, including burrowing owls

(*Athene cunicularia*), small grassland birds like the savannah (*Passerculus sandwichensis*) and grasshopper (*Ammodramus savannarum*) sparrows, and herpetofauna such as the California tiger salamander (*Ambystoma californiense*) and California red-legged frog (*Rana draytonii*).

Removal of tall non-native vegetation by livestock also allows native forbs to better proliferate, thereby increasing food and nectar for many federally threatened or endangered butterflies found on the California coast, including the San Bruno elfin butterfly (*Callophrys mossii bayensis*) and Bay checkerspot (*Euphydryas editha bayensis*) (reviewed by Barry et al., 2015). While some opponents of livestock grazing may believe that livestock do not differentiate between native and non-native vegetation, it is possible that the structure and phenology (tall-statured and shade native plants; monotypic swards of annual grasses; earlier growth) (Dyer and Rice, 1999, 1997), as well as the accumulation of substantially greater biomass by non-native vegetation relative to many native plants in California (D'Antonio and Vitousek, 1992), could make them more apparent to livestock, or more likely to be eaten. Moreover, a variety of grazing strategies, as well as different livestock species, may be used to target different weeds at the most vulnerable times in their life cycle (see review by (DiTomaso, 2000; Lerner, 2007; Popay and Field, 1996). This strategy may not be effective in some areas of California, however, where climatic and abiotic conditions are substantially different from the mesic coastal regions we focus on in this review (Kimball and Schiffman, 2003).

Collectively, this information on the potential for multiple beneficial outcomes of targeted grazing suggests that grazing could have substantial benefits for wildfire risk reduction, recreational enhancement, and floral and faunal composition of rangelands. In addition to these ecological and social benefits, many public land agencies, including California State Parks, have identified several items in their strategic action plan which are compatible with, or even mandate, livestock grazing. For example, Strategy 2.2.1 in the California State Parks Strategic Action Plan includes ongoing annual maintenance of cultural and natural resources, which can include, as previously discussed, targeted grazing management to enhance these resources in an economically viable and efficient way. Moreover, Strategy 5.2.7 dictates that leases should be negotiated to maximize revenue potential, which often includes grazing leases (California Department of Parks and Recreation, 2013). The California branch of the Bureau of Land Management also requires addressing noxious weeds and marijuana eradications, which can be supported by the very presence of effective livestock grazing management. In fact, the Strategic Action Plan for the Bureau of Land Management (2012) mandates that these landscapes be “working” by providing sustainable livestock grazing opportunities. These public lands, while supported by taxpayer dollars, can thus be maintained as “working landscapes” via well-managed livestock grazing, which could provide a host of vegetation management services, support cultural traditions, and procure revenue for further enhancement of public land holdings.

### ***Costs of livestock grazing and recreation***

Conversely, rangeland degradation is often blamed on livestock grazing, although recreation has also been implicated, as well as urban growth and development, land fragmentation, farming, mining, introduction of invasive species, water development and diversion, elevated CO<sub>2</sub> and climate change, and human-caused alterations to fire regimes (Forest Service, 2012; Hobbs et al., 2008; Morris and Rowe, 2014). While poorly managed grazing may result in a host of negative environmental repercussions (Elrlich, 1990; Huntsinger et al., 2007; Resnik et al., 2006; Tempest, 2004), much research has been conducted in mitigating or eliminating these negative impacts (Briske et al., 2011), and most producers implement practices to reduce, mitigate, and reverse them (Anderson, 1989; Briske et al., 2011; Havstad et al., 2007). Moreover, most research

regarding the negative impacts of livestock grazing has been conducted in the arid inland regions of the western U.S.; these areas will respond differently to grazing than the coastal regions (Bush et al., 2006; Hayes and Holl, 2003) on which we focus in this review. Considerable spatiotemporal variation exists in the effects of grazing on a variety of aspects of rangeland ecosystems, and these effects may also be dependent on the intensity and type of grazing management (Fabricius et al., 2003; Fuhlendorf and Engle, 2001).

Recreational damage to infrastructure from heavy or inappropriate recreational use, illegal activities from park users' on public lands (e.g., illegal marijuana plantations, vandalism), and gates being left open resulting in escape of livestock are some potential hazards of recreation on public lands. Some parks post signs at gates requesting that park users close gates behind them to contain livestock (Barry and Amme, 2009), but these are often not effective, and some recreationists purposefully leave gates open or cut fencing due to a strong personal disagreement with livestock grazing in parks (Wolf et al., unpublished results). Other potential impacts of poorly managed or unmanaged recreation on rangelands include erosion, trail damage, increased trail footprints, trampling up to 1 meter off-trail, soil compaction (particularly from horses), increased spread of invasive plants, damage to plants, disturbance to wildlife, damage to cultural and aesthetic resources, littering, nutrient loading, disturbances to wildlife that alter behavior, habitat fragmentation, and vandalism (Fire and Resource Assessment Program, 2010; also see review by Jordan, 2000).

While potential danger from livestock is commonly cited for removal of grazing from public lands, recreationist injuries are not always the biggest point of contention for some grazing opponents. The fact that private graziers will benefit from public lands is a common complaint regarding grazing leases. The Alameda Creek Alliance contends that because public lands are public domain, the biggest beneficiary should be the public; however, when grazing occurs, they view public lands as imparting the greatest benefit to private ranchers. The fact that millions of visitors utilize these lands each year (Tempest, 2004) may, however, outweigh potential benefits to the grazier, at least in terms of intangible benefits derived from recreation on public lands. Moreover, food and fiber from cattle operations may be sold in local and regional communities, imparting a substantial local economic benefit (Barry, 2014). The very existence of negative sentiments about livestock may sway public opinion regarding grazing in recreational areas. The Cattle Free By '93 movement (Anderson, 1989) and other extreme environmentalist viewpoints advocate for the complete removal of domestic livestock from all rangelands, and public lands in particular (Ferguson and Ferguson, 1983; Schneider, 1999). Such viewpoints may hinge on animal-rights sentiments (The Humane Society of the United States, 2014), or the common misperception that grazing is always bad for the environment (Brunson and Steel, 1996). Additionally, past experience and demographics are important factors in sentiments regarding grazing on recreational lands: recreationists with more experience on grazed lands (Sanderson et al., 1986), hunters (as compared to hikers, see Brunson and Gilbert, 2003), fishers (Sanderson et al., 1986), and rural citizens (Howell and Laska, 1992) – particularly in regions with heavy economic dependence on rangelands (Brunson and Steel, 1996) – have less negative perceptions of grazing on shared lands (reviewed by Barry, 2014). Nevertheless, some recreationists indicate that they would alter their activities if the effects of grazing became more apparent (Sanderson et al., 1986).

Other common complaints about livestock grazing in recreational areas, including cow manure, flies that may come with cows, occasional fouling of water holes, and damage to trails in wet areas and seasons, may be a public nuisance for recreationists frequenting grazed areas

(Tempest, 2004). Recreationists may be fearful of livestock, sometimes due to a previous negative experience, but more often due to a lack of experience with livestock (Barry, 2014; Huntsinger et al., 2007; Resnik et al., 2006; Ringgold, 2009; Sulak et al., 2008). On rare occasion, injury, death, or threats to people, companion animals, *or* livestock (by people or their companion animals) may occur, usually due to a lack of awareness or experience in working around livestock with young (Barry, 2014, 2009; Tempest, 2004).

Despite the existence of some negative sentiments towards grazing animals on public lands, negative interactions are actually quite rare. Over 2 million visitors enjoy the San Francisco Bay Area parks each year, yet less than 7 of them experienced a real or perceived negative interaction with livestock (Barry, 2009; Barry and Amme, 2009). When East Bay Parks created a reporting system in 2004 to allow park users to report incidents of negative interactions with livestock, only 18 incidents were reported over a 4-year period (< 0.000225% report rate from 2004-2007). No patterns were evident from these reports to assist in revealing repeated circumstances under which livestock acted aggressively (e.g., negative interactions between dogs and cattle were not the most common complaint, as expected). In almost 6,700 surveys for the East Bay Parks Regional District – while grazing was not specifically addressed – only 10 public comments mentioned grazing, and only two (< 0.03%) requested grazing be removed from the parks (Barry and Amme, 2009). However, for the officials of the Sunol Regional Wilderness, just a few perceived threats – even with millions of visitors a year – creates an “unacceptable” level of risk and could eventually result in removal of livestock grazing (Tempest, 2004).

In Barry’s (2014) review of photos and comments about parks and other related topics on Flickr, a photo-sharing website (Yahoo, 2015), less than 2% of comments about cows were negative, over 23% were positive, and only about 5% were fearful (the remaining were neutral or descriptive). Of fearful comments, less than 1% described aggressive livestock chasing or charging people. Many individuals making fearful comments indicated a desire to overcome that fear, and people in parks were generally significantly more fearful of snakes than of livestock (e.g., 44% of photos tagged with “rattlesnake” and 14% of those tagged with non-venomous snakes, were fearful). These and other potential risks on public lands may not be associated with livestock at all. Rattlesnake bites (California Department of Fish and Wildlife, 2015), recreational injuries (e.g., twisted ankles when hiking) (Tempest, 2004), tick bites (Salkeld et al., 2015), and other wild animals (e.g., mountain lions) (California Department of Fish and Wildlife, 2014) are all potential risks when recreating on public lands. In the case of park users desiring to conquer fears of cattle, this represents an opportunity for managers to provide an educational service and learning opportunity to these recreationists. Analysis of this photo-sharing data revealed that while land managers often assume recreationists oppose livestock grazing in parks, comments about cattle grazing in San Francisco Bay Area parks, at least, were generally positive (Barry, 2014).

In the Stanislaus National Forest, as on many other public lands, recreationists are asked to remain at least 6 feet away from cattle to avoid upsetting livestock, which like any other prey animal, may become agitated if they feel threatened when a person, dog, or other unfamiliar object such as a bike, comes within their “flight zone” (Lockinger, 2002). Like most animals, this may stimulate them to either charge if they feel cornered or think their young are in danger, or they may suddenly run away, potentially knocking over any person or thing in their way (Holland, 2015). Moreover, ranchers themselves understand that as resources become increasingly limited, competition for land also increases, and if they do not or cannot work with the public to create mutually beneficial, positive (or at least not negative) relationships between

livestock presence and recreationists, they may not be allowed to continue their way of life. This provides substantial motivation for graziers to proactively reduce fearful or negative interactions. To mitigate this risk, ranchers will generally remove any offending animals, and if they cannot identify the “aggressor”, they will often remove many other animals matching the description to reduce danger from potentially aggressive animals. This willingness to work with the public helps to leave only those animals that are comfortable with, and safe around, wandering recreationists (Tempest, 2004).

## **Common Livestock-Recreation Interactions and Associated Concerns**

### ***Hunting and fishing***

Hunters are more likely to have favorable attitudes toward grazing in recreational areas, as compared to hikers. They are also more likely to believe that grazing enhances their experience - even though hunters were significantly more likely to see livestock or their effects because they tend to travel further than most recreationists and travel off trails more frequently (Brunson and Gilbert, 2003). However, hunting is declining in the U.S. while hiking is increasing (Forest Service, 2012), so the influence of hunter sentiment on grazing of public lands may be less than that of a growing hiker population. Fishers have lower tolerance of range management activities than hunters due to the common perception that cattle foul streams, rivers, and lakes. Damage to riparian habitats is of particular concern, as cattle may congregate and “camp” in these areas for water, forage, and shade if allowed by land managers. Trampling of sensitive plants, pegging of wet ground, slumping of streambanks, impacts on aquatic flora and fauna, and changes to hydrology and stream channel morphology may be quite negative (Belsky et al., 1999; Fleischner, 1994) if livestock presence is not well-managed (Bush et al., 2006). However, many managers fence livestock out of waterways and other bodies of water, at least seasonally, so interactions between fishers and livestock grazing may not often occur on public lands. On private lands, some ranchers allow fishing, or are fishers themselves, and do not have concerns regarding water quality or impacts on fish populations. This may be due to good management, or perhaps because they do not observe or identify negative impacts, even if they do exist (Wolf et al., unpublished results).

### ***Off-road vehicles, biking***

Off-road and all-terrain vehicle use, including motorized bikes, often prompt negative reactions from land managers because of trail damage, impacts on forage production, and occasionally negative direct interactions. Occasionally recreationists ride in a reckless or potentially dangerous manner, which is problematic when cattle are present. Non-motorized bikers are a similar concern, as bikers are sometimes observed riding at high speeds directly through livestock herds without apparent concern for their own – or the animals’ – well-being. Riding at high speeds erratically through or near herds could spook livestock and cause accidents that can injure recreationists, other nearby individuals, companion animals, livestock managers, or livestock. Additional conflicts may occur when fencing is cut and fences are left or tied open by users who desire unobstructed access to recreational areas. When fences are damaged or gates opened inappropriately, livestock may access environmentally sensitive or dangerous areas: livestock are often purposefully excluded from certain areas to protect wildlife species at sensitive times of the year, to keep them from entering roadways and creating dangerous driving conditions, or to keep specific animals (e.g., bulls during the breeding season) in a particular

area. Therefore, recreationists altering fences and gates may inadvertently cause environmental damage and endanger wildlife and people (Wolf et al., unpublished results).

### ***Hiking, dog-walking, and other day-use***

Rare incidents have been reported in which overprotective mother cows with young calves have charged and occasionally chased, butted, or stomped hikers venturing too near their calves. Officials estimate that while less than five injuries are reported annually at the East Bay Regional Park District, the largest open park district in the U.S. at 96,000 acres (38,850 ha), many more incidents not involving injury, or involving only minor injuries, could go unreported (Tempest, 2004). However, other incidents initially reported as “attacks” were later revealed to be less dangerous. For example, one park user reported being attacked by a cow, but in subsequent interviews, expressed that the cow had looked ‘menacingly’ at them, and when they turned to run away, they tripped on a tree root and fell, sustaining minor scrapes and bruises. Many reports of attack and injury follow along similar lines, representing more of a perceived feeling of impending danger, rather than actual aggressive or threatening behaviors. While these perceived threats may not warrant the same response from grazing and land managers as would an actual attack, they do reveal a need for better education regarding livestock behavior (Wolf et al., unpublished results).

Hikers with dogs post more negative comments on Flickr about cattle in parks than hikers without (Barry, 2014). Walnut Creek’s Park, Recreation, and Open Space Commission removed cattle from the park in 2010 after park user complaints about cattle trampling trails and attacking dogs and people. However, subsequently increased fuel loads and fire hazards from a lack of grazing had many residents clamoring for the reinstatement of cattle grazing (Nardi, 2012). From a livestock perspective, dogs may be viewed as a particular threat, as livestock cannot easily distinguish between domestic canines and coyotes, and dogs off-leash may chase and harass grazing animals (Holland, 2015). Some livestock managers have noted park users encouraging their dogs to “herd” animals, perhaps thinking that all dogs possess a herding instinct and as such, the opportunity to herd livestock would be a positive enrichment activity. However, most dogs do not understand how to behave around livestock, and livestock being chased may react in a defensive or fearful manner, as any animal or human would if chased by a dog (Wolf et al., unpublished results).

While dogs are not allowed off-leash in most parks, many recreationists allow their dogs to run free. Some users contend that off-leash dogs are under voice-control, but many dogs presented with an opportunity to chase livestock or wildlife will not yield to voice command, even if otherwise well-trained (Nesbitt, 2006; Vaske and Donnelly, 2007). While some individuals may bring dogs to feel safer when hiking, the presence of dogs is actually more likely to increase the incidence of dangerous situations, particularly when mother cows have young calves at their sides (Wolf et al., unpublished results). Dogs may also chase or injure other dogs, children and other park users, or wildlife, and should always be kept on leash on public lands unless areas are specifically designated for off-leash recreation (Nesbitt, 2006; Vaske and Donnelly, 2007; Westgarth et al., 2010).

### ***Floral and faunal appreciation (including photography)***

Millions of visitors to California’s public lands enjoy viewing and photographing wildlife, painting, drawing, or photographing rare native plants, bird-watching, and catching or documenting butterflies and other insects (Tempest, 2004, Wolf et al., unpublished results).

However, livestock are generally managed with fencing, and this may impede the movement of large wild mammals and recreationists (Fleischner, 1994), although deer fencing and other smooth-wire fencing with larger gaps between wires may also be utilized (Paige, 2009). Large predators may also be eliminated by land managers when they become “too” problematic (e.g., individual mountain lions or coyotes that consistently prey on livestock or stalk humans; see Freilich et al., 2003; Kellert, 1985). Other “pest” animals may also be removed due to beliefs or evidence that they are damaging to the environment or negatively impact livestock weight gains. Rodents, particularly ground squirrels, create bare ground and compete with other grazing animals for forage, and as such are often targeted by ranchers for removal (Matschke et al., 1983). These removal efforts may upset park users, and if conducted in an inappropriate manner, could represent a danger to other animals and could have negative impacts on other trophic levels (e.g., rodenticides and other lethal methods might endanger other wildlife or companion animals) (Treves and Naughton-Treves, 2005; Warburton and Norton, 2009). However, some managers understand that they have limited options for controlling predation or impacts from “pest” species on public lands, and factor this in to their grazing plan (Wolf et al., unpublished results). Moreover, there is significant potential for targeted livestock grazing to enhance wildlife forage, and in particular, habitat for many sensitive or rare species negatively impacted by high biomass accumulation from invasive Mediterranean plants common on California’s rangelands, which could improve opportunities for viewing wildlife (see previous section: “Benefits of livestock grazing for public lands management and recreation”).

### ***Heritage, cultural value, and archaeological sites***

Scenery and spiritual renewal may not fit well into an economic or ecological model of land management, but failure to manage for these values leads to contention over common management practices (Brunson, 1992). While heritage or archaeological sites may not directly require exclusion of livestock, digging to install fence posts and new fencing could damage valuable resources. Many livestock managers have a strong track record of avoiding damage to these sensitive areas on public lands by obtaining permission before making any alterations in these areas (Wolf et al., unpublished results).

### **Facilitating Positive or Neutral Livestock-Recreation Interactions**

General consensus among grazing and land managers is that limitation and removal of grazing stems largely from a lack of understanding regarding the ecological effects of well-managed grazing, the evolutionary relationships between grazing animals and plants, and the reasons for using grazing as a tool to manage lands (Wolf et al., unpublished results). The inherent “need” for grazing in some landscapes that evolved with ungulates is heightened in the face of highly successful exotic plant invaders (Foin and Hektner, 1986; Hayes and Holl, 2003). To facilitate more positive livestock-recreation interactions, a multi-pronged approach to education and management is likely needed. Carefully constructed public surveys, educational workshops, improved on-site signage, more user-friendly and up-to-date websites and educational materials, increased land manager presence, changes in livestock management, and additional services provided by land managers may all assist in improving relations between park users and livestock graziers while enhancing the user experience and supporting local economies. American Hiking Society’s ambassador Jennifer Pharr Davis clarifies the role of public education in public lands management by saying “The key to protecting, maintaining, and funding trails is engagement” (American Hiking Society, 2014a). Facilitating engagement and

open conversations without hostility is critical to sustaining wildlands. Reaching millions of park users will be a challenge, although not an insurmountable one. Open dialogue between land managers and recreationists is necessary to educate each stakeholder on the potential risks and benefits of grazing on public lands. Fortunately, such opportunities for engagement are available, and most public lands' graziers and agencies are already managing for livestock-recreation interactions; we describe several of these approaches in the following sub-sections.

### ***Public education through surveys***

It is generally assumed that surveys reveal pre-existing opinions that guide individual actions. However, research has shown that when an opinion has *not* been formed on a given topic, respondents may actually construct answers (and opinions) at that moment, and may even create answers based on previous questions in the survey (Tourangeau and Rasinski, 1988). Moreover, Brunson and Steel (1996) found many survey responses about rangeland management were noncommittal, and thus, potentially vulnerable to change given the right strategy. Therefore, surveys and other methods seeking to solicit public opinion may actually do more to *create* public opinion than to record it. Moreover, respondents may then act in accord with their responses, making the wording of surveys potentially important in creating public opinion and swaying public action (Simmons et al., 1993). Thus, providing park users with information early on (i.e., prior to encounters with livestock) may contribute substantially a better-informed public (Brunson and Steel, 1996).

It is important to note that individuals who participate in forums or surveys may come from relatively extreme or polarized camps and may not represent average public opinion or desires regarding a particular issue (Allen, 1998). However, Fortmann (1990) showed that while it is often assumed that complaints and resistance to management practices on public lands come from extremist groups, two-thirds of formal complaints about forestry practices were actually from local residents, with over half having valid, science-based arguments; only 4% of complaints originated from environmental activists. Others have found that widely publicized and easily accessible public forums successfully capture public opinion (Gundry and Heberlein, 1984). The utility of surveys in capturing average park user opinion is not entirely clear, but at the very least could be used to stimulate thinking about multiple uses and grazing on public lands.

### ***Social media and the internet***

New technologies and increased public engagement via widespread use of the internet and smart phone applications to obtain information may ease this process. Social media is an emerging platform by which to develop interactive and collaborative solutions to “public commons” problems, and may be utilized to more accurately gauge public opinion and values than traditional information-gathering methods. For example, despite the common perception that park users in general view livestock grazing in public parks as negative (Nardi, 2009), Barry's (2014) assessment of recreational park photos and associated user comments revealed that very few recreationists hold overtly negative sentiments regarding cattle in parks. For the few park users that made fearful comments on photos tagged with cows in the East Bay Regional Parks, they also indicated a desire to conquer those fears. This represents an opportunity for managers to provide an educational service and learning opportunity to recreationists. Additionally, some park-goers did not understand why cows were present at all. In these situations, managers might overcome negative sentiments by explaining how well-managed grazing can be a beneficial tool

in parks for fire risk reduction and increasing wildflowers and biodiversity (Gelbard and Harrison, 2003); these beneficial changes would likely make the park a more enjoyable place to visit (Barry, 2014). Nonetheless, some otherwise environmentally-motivated individuals may still oppose grazing, even when explicitly conducted to support a positive ecosystem service, if livestock grazing would restrict their personal choices. In other words, what an individual *thinks* they will support may change when that action restricts or impinges upon their personal freedom and movements (Noe and Hammitt, 1992).

With most traditional approaches to elucidating public opinion, direct public input is either non-existent or very limited. Social media may therefore lend critical insight to public sentiment and help guide public policy and/or development of land management protocols that may better facilitate positive (or neutral) livestock-recreation interactions. Facebook, Twitter, and other similar web-based applications can increase dissemination of information about livestock in public parks and the compatibility of grazing and recreation, both of which can be important for maintaining open spaces. The Wildlife Mentoring of Los Angeles Facebook page, for example, provides educational posts about living safely with wildlife in the wildland-urban interface where coyotes may pose a threat to pets and small children (Wildlife Mentoring of Los Angeles, 2015). Thus, Facebook users may obtain information in their live feeds about coyote behavior that they would not otherwise receive, and this may reduce the incidence of human-wildlife conflicts. Such efforts could be similarly applied to livestock grazing on public lands.

### ***Educational programs and visioning processes***

Special events and interpretative programs to educate interested park-goers about livestock grazing in parks could be a valuable tool for increasing positive livestock-recreation interactions (Barry and Amme, 2009). Cooperative extension events, public workshops, and other events to encourage public participation and education may prove worthwhile, although the limitation of attracting only a small subset of particularly interested individuals, rather than a random sample of potential park users, may reduce the effectiveness of this approach. Working groups (Vavra, 1998) in which the public participates in development of mission or vision statements for public lands could double as an educational tool for park users, while aiding managers in understanding the particular concerns of public land visitors. This could assist in addressing issues that may not otherwise come to light. For example, public participants in a visioning process for Walnut Creek Open Spaces expressed a desire to learn more about livestock grazing on park lands. During this visioning process, maps were created of grazing areas as one potential solution to minimize interactions for park users interested in avoiding livestock completely, but currently this information is only available to public land managers. The East Bay Regional Parks District also implemented the previously discussed reporting system to allow park users to report incidents with aggressive livestock (Barry and Amme, 2009). Such systems may increase user engagement and satisfaction in their ability to quickly voice concerns and address issues.

### ***Field days and outreach workshops***

Other recreation-focused events may be utilized to educate park users and encourage open conversations about multiple uses on public lands. Many park users are interested in becoming involved in improving park lands and open spaces (e.g., trail maintenance), and this could be an opportunity to educate users about the potential benefits of grazing, as well as helping users feel safe and comfortable around any livestock they might encounter. Events focused on native flora and fauna could also prompt conversations about the benefits of livestock on public lands,

particularly in the face of high levels of exotic plant invasion. For example, The American Hiking Society promotes a National Trails Day to increase awareness and enjoyment of the outdoors, and incorporates recreational activities and volunteer work (American Hiking Society, 2014b). Some ranchers have entertained the idea of having “Meet the Rancher” days, such as an open forum where the public can learn more about grazing on public lands while enjoying a locally-produced lunch and tour, asking questions, and interacting with livestock. Large-scale, highly-publicized speaking events may also be particularly helpful in disseminating information to an otherwise unengaged public. Allan Savory, the controversial promoter of the concept of planned livestock grazing to reverse climate change and desertification, gave a highly publicized “TED talk” that rippled across the internet. Prior to this talk, Savory’s message was much less well-known, but as of August 2015 the video had over 3 million views on the TED website, not including views on other websites and forums (Savory, 2013). Similarly, if a particularly engaging public figure with sufficient knowledge and experience to speak about livestock grazing on public lands was available, such an avenue might encourage increased public engagement and conversation.

### ***Popular press, factsheets, and signage***

Printed materials such as articles in popular press venues like outdoor recreation magazines, (e.g., Backpacker, TrailGroove, Outside), national and local newspapers (e.g., The New York Times, Contra Costa Times), online websites and forums (e.g., [www.hiking-for-her.com](http://www.hiking-for-her.com), [www.hikingtripreports.com](http://www.hikingtripreports.com)), and scientific journals (e.g., The Outdoors Journal, Parks and Recreation Magazine) could increase the number of park users that are aware of the management reasons for livestock grazing, and might assist in navigating trails around livestock. Bulletins and pamphlets can be distributed in person, via email, or through websites to provide more information about the potential benefits of livestock grazing in many California wildlands. The University of California’s Division of Agriculture and Natural Resources, for example, publishes factsheets about the benefits of well-managed livestock grazing (Barry et al., 2015; Larson et al., 2015).

Educational signage may provide site-specific information to assist users in navigating areas where livestock graze along with warnings of rattlesnakes, cougars, and other potential wildland dangers (Barry and Amme, 2009; Tempest, 2004). East Bay Regional Parks District developed a brochure to assist the public in safely navigating areas with livestock, as well as providing information about grazing planning and benefits of grazing management in the parks. In this brochure, the park acknowledges potential negative impacts of domestic grazing livestock (e.g., muddy, pocked ground in the rainy season from animal impact, manure, and rare injuries), and emphasizes the importance of vigilant grazing management to balance proper resource management and enhancement of biodiversity with an enjoyable user experience (East Bay Regional Park District, n.d.).

### ***Information sources and language***

Brunson and Steel (1996) found that in general, the public is “ambivalent” about science, technology, and resource managers, and may be suspect of information if it comes from a source in which they have low confidence. However, universities are viewed as more credible information sources than government agencies and the livestock industry, and as such, partnerships with universities may be particularly fruitful (Steel et al., 1990). Whatever the state of average knowledge regarding natural resource management on rangelands – and in particular

public lands where grazing may occur – it is apparent that not only is the public at least somewhat concerned, but range managers are cognizant of this concern and are working hard to generate socially-acceptable solutions to balance multiple resource uses and enhance wildland ecosystems.

However, land managers and agencies also recognize that working harder to educate the public may not automatically confer a consensus about grazing on public lands. Keeping this awareness at the forefront of discussions may reduce initial frustration among land managers if changes in public opinion regarding livestock grazing on public lands are not immediately forthcoming. Theoretically, this may lead to more patience with the process, and creative, collaborative approaches to multiple-use management of grazed recreational lands. When range managers and park rangers deliver this message, they can refrain from using technical, jargon-based vocabulary that may seem obfuscating. They may also steer clear of the “science always has a solution” paradigm that can create divides between the general public and natural resource managers, recognizing that social and cultural values of citizens are often strongly held, and unlikely to change quickly (Brunson, 1992; Brunson and Steel, 1996).

### ***Livestock grazing management***

Interviews with graziers, public lands’ managers, and livestock and rangeland consultants revealed a variety of practices that graziers and managers can and do implement which might improve livestock-recreation interactions or reduce them altogether (Wolf et al., unpublished results); the information in this section briefly summarizes a variety of these management tactics as revealed by interviewees and surveys.

Many graziers will engage park users one-on-one to answer questions about grazing and demonstrate safe interactions with livestock, sometimes opening gates for passers-by when possible. This is one potential way to create allies out of recreationists, and the large numbers of park users on public lands can be a benefit to the grazer, as more eyes on the land and animals can be helpful in the event of an emergency or illegal activity. As previously mentioned, signage is an easy way to notify recreationists of livestock presence, and provide simple tips on navigating areas with livestock, clarify what constitutes an emergency, and explain what park users’ should do in the event of an emergency. These signs should have the local park agency phone number, but can also direct users to call 911 in case of a true emergency.

Avoidance strategies may include training and habituation of livestock to common park stressors, such as hikers, dogs, bikers, ATVs, and horses. Selection for temperament is also commonly practiced; graziers prefer gentle, calm animals in the first place, as this is conducive to good weight gain, but has the added benefit of reducing negative interactions between livestock and park users. Many graziers prescribe to principles of low-stress handling, which may also induce animals to remain calm when humans, dogs, or other stressors are present. Animals that seem aggressive or sick are removed from herds, and if an offending animal is reported but cannot be exactly identified, graziers will generally remove several animals matching the offending animal’s description to err on the side of caution. Livestock may be moved to areas of lower recreational usage during times that might represent an increased risk, such as breeding and calving (kidding, lambing) seasons. Moreover, managers generally choose to perform management activities (e.g., movement of animals between pastures, health checks) during times of lower recreational use (e.g., avoiding weekends and holidays).

Finally, many graziers and agencies use social media, the internet, and printed materials, or participate in workshops and field days (as described in previous sub-sections) to further

inform the public about the reasons for grazing and safely navigating areas with livestock. Some graziers go so far as to provide additional services in parks, including enhancement of oak woodland habitat, picking up trash from park users, and maintaining watering points for use by horses, dogs, and wildlife even when livestock are not present. These services may then enhance the recreational experience and even increase wildlife habitat and improve other ecosystem services.

Recreationists can also contribute to safe livestock-recreation interactions by reading all signs and educational materials, checking for alerts on social media and websites prior to visiting parks, asking questions when they encounter graziers or parks' staff, keeping dogs on-leash and under control at all times, maintaining a safe distance from livestock, moving slowly and calmly through areas with livestock, never interacting directly with livestock (especially young animals), and reporting any concerns or emergencies. In the event of an emergency involving livestock, park users should provide as much information to emergency personnel as possible to facilitate a quick response. This includes taking photos from a safe distance; noting locations, waypoints, trail markers, or distinguishing landscape features; and describing the animal in detail, providing eartag numbers if possible (a zoomed-in photo may allow individuals to provide eartag numbers while maintaining a safe distance). It should be pointed out that young animals are often left alone while their mothers eat or drink, and unless the animal is clearly injured, this does not constitute an emergency.

### **Management Implications and Information Needs**

Changes to wildland habitats due to climate change and land-use conversion will continue to threaten wildlife habitat and reduce connectivity and migration pathways, particularly in the western U.S. (Resnik et al., 2006). Many impacts are projected to increase substantially in the coming decades – more so in the western U.S. where the population growth rate is higher than in the eastern U.S. – and are likely to have greater impacts in low-density, rural landscapes (Forest Service, 2012). In the western U.S., nonmetropolitan population growth is three times higher than in the rest of the U.S., and occurs disproportionately on forests and rangelands (Hansen et al., 2002). The goods and services demanded from wildlands by the public will increase, and balancing the needs of a rising population with sustainable natural resource management will be a continuing challenge. Grazing lands will decrease in area, while demand for recreation (Brunson and Steel, 1996; Forest Service, 2012) and livestock products will simultaneously increase (Stoll-Kleemann and O'Riordan, 2015).

While both poorly managed recreation and livestock grazing can have negative impacts on wildlife and ecosystems, increased demand for already limited recreational and grazing lands may actually help save these lands in the long-term (Bush et al., 2006; Forest Service, 2012). Keeping these areas as “working landscapes” that provide social, cultural, and financial benefits may be one of a few ways to protect dwindling rangeland habitats, as open spaces not providing any economic return are often targeted for development (Fire and Resource Assessment Program, 2010; Resnik et al., 2006). However, the interactive effects (and potential conflicts) of increased recreation and grazing on a host of ecosystem goods and services are less predictable. As such, land managers and graziers must work collaboratively to develop synergistic approaches for simultaneously grazing livestock and providing recreational opportunities on public and private lands (Forest Service, 2012; Sayre, 2005; Walker et al., 2002) in the Central Coast to avoid increased conflict and possibly increased limitations and regulations to either activity (Plieninger et al., 2012; Resnik et al., 2006). Opportunities for public education and

learning may also mediate negative perceptions or concerns about multiple uses of these lands (Barry, 2014; Sanderson et al., 1986). Nonetheless, this must be approached with a strong respect for social values of the general public and an open mind by educators (Brunson, 1992), and should be geared toward local circumstances and historical land-use, as what works well under one set of conditions may not transfer to another (Shindler and Neburka, 1997).

Given the very low incidence of negative livestock-recreation interactions, livestock grazing and recreation appear to be compatible on most public lands, even those used intensively and for a variety of purposes, and could enhance ecosystems while satisfying community needs (Barry and Amme, 2009). It is likely that already rare negative livestock-recreation conflicts can be further minimized and the benefits of these concurrent uses maximized with appropriate policies, management, and creativity and leniency on the part of both livestock managers and recreationists. Additional information would be helpful to assess grazer amenability to making necessary changes to management in order to facilitate more positive livestock-recreation interactions, and proactive public and agency outreach programs may be implemented to support these efforts. Interviews and surveys were utilized in an assessment of land manager, rangeland consultant, and graziers operating on the central and northern coasts of California, to investigate on-the-ground experiences with livestock grazing on recreational lands, and this may lend critical insight into further promoting positive livestock-recreation interactions on public lands (see Wolf et al., unpublished results).

### **Conclusion**

Novel approaches to public education and collaborative land management are critical to reducing negative livestock-recreation encounters and enhancing the many benefits that these land uses and ecosystem services provide. Heightened desire for recreational lands, the need to manage for fire risk reduction and weed invasions, the economic benefit imparted to local communities from food and fiber production by livestock grazing, and interest from ranchers, land managers, and the public in the use of livestock as a tool to improve ecosystems makes a multiple-use approach to rangeland management desirable. Increased concurrent livestock grazing and recreation on public lands seems an entirely plausible and mutually beneficial strategy for sustainably managing public lands while simultaneously increasing economic, ecological, and cultural values.

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## Figures and Tables

### Figure Captions

Figure 1.

Number of article records containing the search terms "recreation" AND "livestock" by year from a search of the Web of Science database on May 24, 2015.

Figure 2.

Educational signage to notify recreationists of cattle presence, and provide safety suggestions for interacting with cattle (East Bay Regional Parks District).

### Figures

Figure 1.

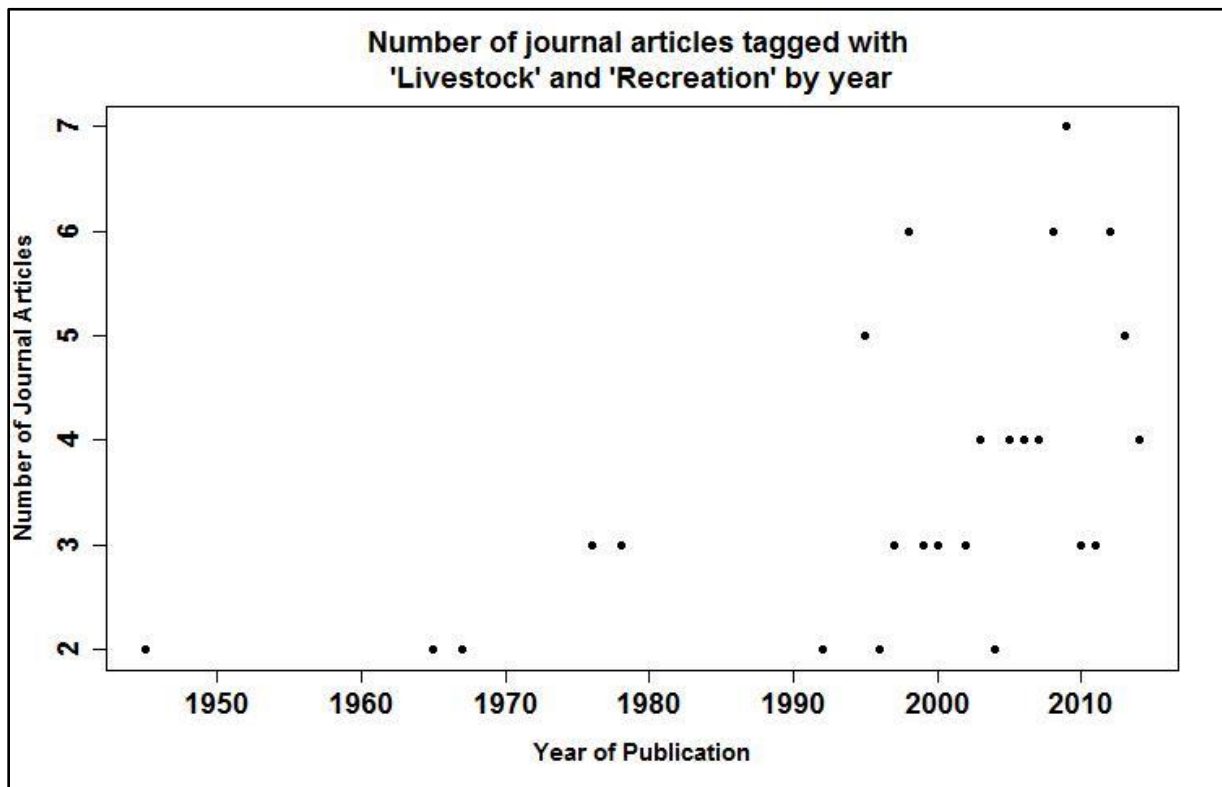
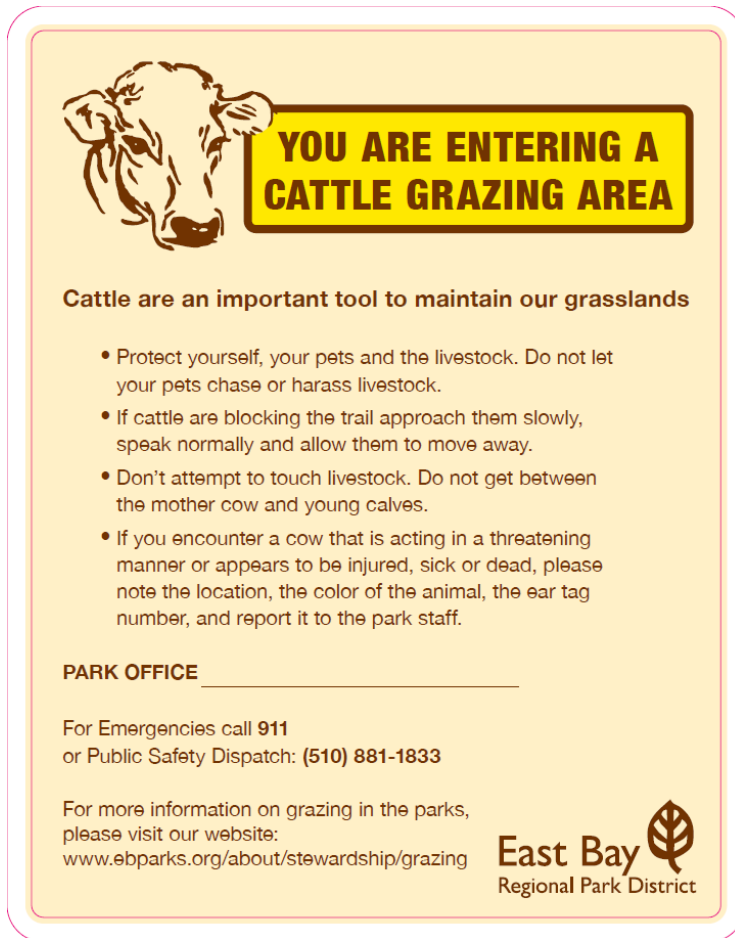


Figure 2.



**YOU ARE ENTERING A CATTLE GRAZING AREA**


**Cattle are an important tool to maintain our grasslands**

- Protect yourself, your pets and the livestock. Do not let your pets chase or harass livestock.
- If cattle are blocking the trail approach them slowly, speak normally and allow them to move away.
- Don't attempt to touch livestock. Do not get between the mother cow and young calves.
- If you encounter a cow that is acting in a threatening manner or appears to be injured, sick or dead, please note the location, the color of the animal, the ear tag number, and report it to the park staff.

**PARK OFFICE** \_\_\_\_\_

For Emergencies call **911**  
or Public Safety Dispatch: **(510) 881-1833**

For more information on grazing in the parks,  
please visit our website:  
[www.ebparks.org/about/stewardship/grazing](http://www.ebparks.org/about/stewardship/grazing)

**East Bay**   
Regional Park District