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Targeted and Prescribed Grazing in California's Central Coast Region

This paper contains a broad overview of what is known about targeted and prescribed grazing practices and how they are implemented in the Central Coast region of California. It is composed of two parts. The first part, which follows a brief description of the geographic scope of the research, is a summary of current knowledge of targeted and prescribed grazing as a means of accomplishing resource management goals, derived from a review of the literature on the topic published as of August 2017. Publications relevant for the review were identified by searching for the key phrases "targeted grazing," "prescribed grazing," "deferral grazing," and "conservation grazing" in the University of California Rangelands Research and Education Archive, the online databases BIOSIS and AGRICOLA, and the archives of the journals *Rangelands*, *Journal of Range Management*, and *Rangeland Ecology and Management*. Emphasis was placed on studies implemented within the Central Coast region of California, with supplementary information derived from studies taking place in other regions to expand upon topics common to all targeted grazing systems.

The second part of the paper examines how the principles of a targeted grazing system, as defined by the literature, are put into practice by ranchers, land managers, and agency personnel

in the Central Coast region. The data informing this discussion came from a survey of Central Coast Rangeland Coalition members. (The Central Coast Rangeland Coalition is composed of ranchers and land managers, conservationists, and agency personnel representing rangeland stretching from San Francisco Bay to Morro Bay; the goal of the coalition is to maintain healthy rangeland ecosystems through the use of sustainable management and cooperative planning between public and private landholders (CCRC 2007)). The survey was conducted through SurveyMonkey® in March 2017, and supplemented with several personal on-site interviews. Three on-site interviews, facilitated by Dr. Larry Ford, were with land managers who had received grazing systems advice and detailed written grazing plans from Dr. Ford, in association with other consulting groups. Two further interviews were with livestock producers practicing targeted grazing on a large scale within the Central Coast region.

The geographic scope of the research: California's Central Coast region

As defined by the USDA, the California Central Coast region stretches from the northern edge of Lake County through the southern edge of San Luis Obispo County and includes the entirety of Lake, Sonoma, Napa, Marin, Contra Costa, Alameda, San Francisco, Santa Clara, San Mateo, San Benito, Santa Cruz, Monterey, and San Luis Obispo counties (CDFA 2016). The Central Coast Rangeland Coalition defines the Central Coast region of California somewhat more narrowly as a region bordered by San Francisco Bay in the north and Morro Bay in the south. For the purposes of this paper, the focus will be placed on targeted and prescribed grazing practices within Marin, Contra Costa, Alameda, Santa Clara, San Benito, Monterey, and San Luis Obispo Counties, with some additional studies taking place in Lake, Sonoma, and Napa counties.

The California Central Coast region has a Mediterranean climate, typified by cold, wet winters and hot, dry summers (D'Antonio et al. 2002). Rainfall throughout most of the region averages between 10 and 20 inches each year, although some locales on the immediate coast and in the mountains receive an average of well over 30 inches of precipitation. The vast majority of rain falls during the cooler winter months (Ross 2016).

The Central Coast region of California encompasses approximately 10 million acres, 48% of which are farmed or grazed. Agricultural zones of the region are dominated by fertile soils allowing vegetable and orchard production. Although the highly productive soils make livestock and pasture production a relatively small portion of total agricultural output, approximately two-thirds, or 3.17 million acres, of the agricultural land in the Central Coast region is pasture or rangeland. No other region in California can claim a higher percentage of grazing land relative to total agricultural land (Siebert and Economics 2003).

Grazing to realize conservation goals: terminology and approaches

Many ranchers, land managers, and livestock producers in the Central Coast region manage grazing systems in a way that is intended to achieve conservation-related goals. However, they refer to their practices with different terms, and relevant agencies and organizations do not clarify the situation with consistent terminology. To refer to methods of grazing that place emphasis on achieving natural resource management goals while providing livestock with forage, the Society for Range Management (SRM) prefers the term *targeted grazing*. SRM defines targeted grazing as "the application of a specific kind of livestock at a determined season, duration, and intensity to accomplish defined vegetation or landscape goals."

The society also uses the term *prescribed grazing* to describe techniques used *within* a targeted grazing system to achieve management goals (Butler et al. 2003; Launchbaugh and Walker 2006). In contrast, the United States Department of Agriculture Natural Resource Conservation Service (USDA-NRCS) prefers to use the term *prescribed grazing* to refer to the most inclusive concept, defining it as a conservation practice that "provide(s) adequate nutrition to animals while maintaining or achieving the desired vegetative community on the grazed site" (Butler et al. 2003). The NRCS considers prescribed grazing to be both a primary conservation practice and a means for maintaining wildlife habitat (Butler et al. 2003). To make matters more confusing, both the NRCS and the SRM employ the term *conservation grazing* when emphasizing the goal of conserving biodiversity within grazed lands, often using it interchangeably with targeted or prescribed grazing or to refer to a specific program for which to use targeted or prescribed grazing practices (Butler et al. 2003; Frost et al. 2012; Launchbaugh and Walker 2006). Because these three terms are used throughout the literature to refer to essentially similar practices, the remainder of this paper will use only one of them—*targeted grazing*—to reference grazing practices with conservation or resource management goals.

Additional terms are used in the literature to describe specific grazing strategies used to achieve the goals of targeted grazing. One of these terms is *deferred grazing* (or deferral grazing). The Society for Range Management defines deferral grazing as "the delay of grazing to achieve a specific management objective" (Bedell 1998). Deferral is sometimes referred to as a tool to be used within a prescribed grazing system, much like fencing, water placement, and stocking density. Deferral is often recommended as a method of protecting riparian areas in especially wet periods or times of year when protection from grazing is necessary to allow protected or endangered species to reproduce (George et al. 2011; Launchbaugh and Walker

2006). (In some circumstances, the term *deferred grazing* is used to refer more generally to grazing to meet conservation goals, and in these contexts serves in place of either targeted grazing or prescribed grazing; the International Terminology for Grazing Lands and Grazing Animals, for example, does not include definitions for either "targeted grazing" or "prescribed grazing," but does define "deferred stocking" as "the postponement or delay of grazing or harvesting to achieve a specific management objective" [Allen et al. 2011].)

Rotational grazing (or rotation grazing) simply refers to a system in which grazing animals are moved between at least two grazing sites (Undersander et al. 2002). The Society for Range Management defines rotation grazing as "a grazing scheme where animals are moved from one grazing unit (paddock) in the same group of grazing units to another without regard to specific rest periods or levels of plant defoliation." This suggests that the practice of rotational grazing in and of itself is not necessarily directed toward natural resource management goals. Within the practice of rotational grazing, additional terms—rest-rotation and deferred-rotation—are used to be more explicit about allowing grazing animals access to and then denying them access to grazing land in an effort to allow forage or other ecological factors adequate recovery time before livestock are reintroduced (Allen et al. 2011; Heady 1961). These methods of grazing management are often defined as the opposite of continuous grazing (refer to Heady's 1961 seminal paper, "Continuous vs. Specialized Grazing Systems: A Review and Application to the California Annual Type.") Heady, who uses the term *specialized* to refer to grazing systems containing aspects of deferral and/or rotation, defines continuous grazing as a practice in which grazing animals remain on a defined area of range for at least an entire growing season (if not year-long), usually for as long as weather will permit (Heady 1961).

Various combinations of high-density short-duration rotation grazing systems are discussed and practiced by advocates of the "Savory Grazing Method" and "Holistic Resource Management." Although the creator of these methods, Allan Savory, maintains that these systems of management are more all-encompassing in their approach to resource management and should therefore not be described as grazing systems, they bear some resemblance to targeted grazing systems in that they place great importance on identifying how available resources (e.g. livestock) can be used to achieve a desired natural resource conservation goal. Savory identifies grazing by livestock as only one of a number of available tools, and places emphasis on manipulation of the soil's surface. Savory is also a strong advocate of never reducing stocking numbers even in response to range deterioration, focusing instead on limiting grazing pressure by shortening grazing periods (Savory 1983). In contrast, most targeted grazing practitioners employ both tools—adjusting stocking numbers and grazing duration—to meet resource management goals. Although Savory's management systems have many advocates, some critics argue that claims about their benefits have not yet been supported scientifically, and that they may present some risks to resource conservation (Barry et al. 2015; Briske et al. 2011)

A new approach (sometimes called Adaptive Stewardship Grazing) uses deferral grazing strategies to meet the goals of targeted grazing and focuses on the use of special management areas and flexible use areas. Under this approach, grazing can be applied flexibly to specified areas with timeframes determined by observation of ecological conditions; the desired effects are achieved in the special management areas by removing livestock to sites (flexible use areas) that can tolerate excessive grazing impacts or where special resources are absent or of lower priority (Ford and Group 2011).

The California Wool Growers Association (CWGA), which has previously used the term *targeted grazing*, has been exploring the benefits of using the term *eco-grazing* to describe the service offered by its members (who contract with private or public entities to provide livestock to meet vegetation or livestock goals). CWGA members have suggested that this term may be more self-explanatory to a public unfamiliar with other grazing terminology but interested in utilizing the services of a targeted grazing practitioner (CWGA 2017).

Because targeted grazing practices entail controlling the spatial and temporal aspects of livestock grazing, all targeted grazing systems naturally employ rotational grazing practices as well as deferral practices. However, not all grazing systems employing rotational grazing and deferral practices can be defined as targeted grazing systems. Rotational and deferral grazing can instead focus on achieving livestock production goals through the movement of livestock in response to forage conditions, with conservation goals being either secondary or absent. Therefore, while the terms *rotational grazing* and *deferred grazing* and their synonyms can appropriately be used to describe the aspects of a targeted grazing system, they should not be used interchangeably with either *targeted grazing* or *prescribed grazing*.

Factors under the control of grazing managers

Many factors influence the potential impacts of grazing. It is important for the grazing manager to recognize, first, that many of these factors are *not* under his or her control. California is subject to greater precipitation variability between years than Midwestern states. There also exists a large climatic gradient between different grassland areas within the state, resulting in much wetter grasslands in the northern coastal areas than in the southern inland grasslands. The

spatial and temporal variation in precipitation results in vastly different species composition in different parts of the state, which means that a specific grazing prescription applied to one location in California during a particular year cannot be counted on to produce a similar result in a different location or during a different year (Spiegal et al. 2014).

The main three factors under a grazing manager's control are the intensity of the grazing pressure put on an area, the duration of the grazing application, and the seasonal timing of grazing animals' access (Blanchet et al. 2000). Grazing intensity, the level of grazing pressure put on an area, is influenced by two main variables, stocking rate and grazing capacity, which are defined as the number of animals grazing on a site over a defined period of time and the amount of forage available for consumption on a site, respectively (Wolf et al. 2017). A high stocking rate in a highly productive grassland with high grazing capacity can produce the same grazing intensity as a low stocking rate on more marginal grassland with low grazing capacity. A grazier or land-manager can adjust these variables as needed to fine-tune the impacts of grazing animals and adapt to environmental effects or observed divergence from the stated vegetation goals (Bush and District 2006).

The species of grazing animal is also an important factor to consider, since different species have different impacts on vegetation. Cattle, with their large muzzles and large rumens, are indiscriminant high-volume grazers, limited in their ability to select among forage species and able to digest more fibrous forage than the other livestock species. These characteristics make cattle more suited to graze tall, dense grass stands than species such as sheep or goats. Sheep, with their smaller mouths, are more selective than cattle in what they eat and have a natural preference for forbs over grasses; therefore, sheep may be a more appropriate grazing animal to use when attempting to control weedy forbs. Goats, with their narrow mouths and

dexterous tongues, are preferred over sheep when attempting to reduce the presence of woody species (Launchbaugh and Walker 2006).

Resource management goals and objectives for targeted grazing

The first step in forming a grazing plan encompassing the use of targeted grazing practices is to establish or identify one or more resource management goals that might feasibly be attained through the use of targeted grazing. The next step is to select specific practices or methods that can be implemented to meet those goals. A related step in the planning process is to define, for each strategy or method to be used, an objective for which progress toward realization can be measured. All the parameters involved— the vegetation or habitat, the places that it occurs, the desired results—must be identified explicitly. For example, if the goal of targeted grazing is to reduce maximum potential wildfire intensity on an area of rangeland, two related objectives can be defined: reduce the level of forage on each pasture at the commencement of fire season (May-June in the Central Coast region) and have each head of cattle grazed on that area of rangeland gain an average of two pounds per day. Performance standards for these objectives might be: above-ground plant biomass reduced to 1500 pounds/acre on average in key fire-risk zones and sampled calf weights increased by at least 60 pounds throughout the month of May.

It may be desirable to state resource management goals in a comprehensive manner. A comprehensive goal statement takes into consideration not only the ecological goal of the targeted grazing application and the grazing practices that will be used to pursue that goal, but also addresses potential social and economic impacts of the grazing regimen. In the above

example, a rancher may choose to graze his or her animals elsewhere or seek lease fee credits if the area of rangeland in question cannot supply the necessary gains to make a profit on the cattle. This approach ensures that the targeted grazing plan not focus purely on an ecological goal but also takes into account the well-being of the livestock, the production goals and economic sustainability of the land manager, and the ecological health of the ecosystem within which the targeted grazing practice is being performed (Blanchet et al. 2000; Launchbaugh and Walker 2006). Understanding the ecological processes and biology of the species involved is obviously an important part of the planning process.

Four resource management goals in the California Central Coast region have received the most study for their potential to be addressed by the implementation of targeted grazing practices: fuel reduction to decrease the incidence of fires, control of noxious weeds and invasive species, maintaining or improving upon existing wildlife and endangered species numbers through the establishment of riparian areas and other habitats, and increasing the presence of native grasses and forbs (Bush and District 2006). For the purposes of this paper, the third of these goals has been broken down into two that are more distinct. The resulting five categories, stated directly in the grazing context, are the following: (1) grazing to create and maintain riparian areas, (2) grazing to increase the presence of native plant species, (3) grazing for noxious or invasive weed control, (4) grazing to benefit wildlife and/or endangered species habitat, and (5) grazing for fuel reduction/fire suppression. These goals are clearly interrelated and overlap with each other; the achievement of one goal may benefit (or harm) another goal. For example, maintaining riparian areas may also provide increased habitat to wildlife species which require wooded habitat, whereas grazing for fuel reduction/fire suppression may decrease habitat available to wildlife requiring taller grass stands for adequate nesting habitat or protection

from predators. It is also true that a specific grazing practice may work to realize more than one goal at the same time.

Grazing to create and maintain riparian areas

Allowing livestock continuous access to riparian areas has been shown to be detrimental to riparian health, due to preferential grazing of riparian species by livestock. The animals may simply consume the vegetation that exists in the places they are seeking shade or they may be seeking out vegetation that is still growing late in the grazing season when grass production has decreased in surrounding pastures (George et al. 2011). In contrast, limited access and light to moderate grazing intensities have been shown to have a positive impact on increasing plant species numbers within riparian areas in the Central Coast region (although it is possible that climatological fluctuations within study years are responsible for the observed differences) (Allen-Diaz and Jackson 2000; Allen-Diaz et al. 1998; Marañón and Bartolome 1994). Some targeted grazing programs that include short-term, high-density grazing in riparian areas have had negative impacts on water quality, plant biodiversity, and wildlife habitat; these impacts may be a result of excess exposure to manure deposition as well as soil compaction and erosion. However, the majority of studies on the impacts of grazing on riparian areas have been conducted in continental-type climates with a much different precipitation regimen than in Mediterranean climates. These detrimental effects may not be observed to such an extent in riparian areas in the Central Coast region as long as short-term, high-density grazing is avoided at the wettest times of the year (Gasith and Resh 1999; Larsen et al. 1998). Results seem to be dependent on time, intensity, season, and duration of grazing, in association with past land use

and climatological factors; they are thus highly variable even within the area of the Central Coast region (Allen-Diaz and Jackson 2000; Allen-Diaz et al. 1998; Marañón and Bartolome 1994).

Grazing to increase the presence of native plant species

Some research suggests that perennial plants, including native grass species found in the California Central Coast region, may be more sensitive to grazing intensity than annual plants. At the same time, perennial plants are more likely to be outcompeted by annual species when grazing pressure does not limit the growth of the annual species. Together, these relationships mean that the success of attempts to promote native grass species through grazing is highly dependent on selecting the appropriate duration and timing of grazing (Bartolome et al. 2004). Duration and timing of grazing can prove especially important when attempting to promote or limit the presence of a specific plant species. Carefully timed grazing can be used to effect a decrease in the reproductive capability of undesirable plants by grazing these plants at the time of seed production. Also, because invasive annual plants tend to sprout earlier in the season than more desirable native plants, it is possible to suppress these invasive annuals, and thereby reduce competitive stress on native plant species, by implementing late-winter or early-spring grazing (D'Antonio et al. 2002; Undersander et al. 2002).

Studies attempting to determine whether targeted grazing can have a positive impact on native grass stands in the Central Coast region have so far been inconclusive (Bartolome et al. 2004; Hayes and Holl 2003). Bartolome et al. 2004 observed increases in the populations of native perennial grass species, most notably purple needlegrass (*Nasella pulchra*) and foothill needlegrass (*Nasella lepida*), in test paddocks grazed during either the spring or the summer

months. Continuously grazed paddocks, in contrast, did not exhibit similar increases in perennial plant species. Somewhat unexpectedly, paddocks left ungrazed also experienced a rise in the number of native perennial plant species present. As this study took place over the span of five years of greater-than-average rainfall following six years of drought, it is difficult to gauge whether, in this instance, the observed positive effects on native plant species numbers could be attributed to the timing of grazing treatments. If the observed results are dependent more on rainfall amounts, this phenomenon may help explain the fluctuating perennial grass species presence in some Northern California grasslands long excluded from grazing. Although these areas did not experience a change in grazing management for over 50 years, the density of purple needlegrass decreased by half between 1958 and 1979, returned to its original levels by 1991 and decreased again by 2000, suggesting that rainfall effects may have a superseding effect over grazing effects on the presence native plant species (Merenlender et al. 2001).

Grazing for noxious or invasive weed control

Targeted livestock grazing can decrease the reproductive capability of noxious weeds and unwanted invasive species if those species are grazed before they are able to effectively disperse seed. To achieve this impact, it must first be determined at which points in its life cycle the targeted species is palatable and to which grazing species, as well as when the plant's reproductive capabilities may be most detrimentally impacted by grazing (D'Antonio et al. 2002; Henderson et al. 2012; Wallace et al. 2008).

Several weeds that persist in rangeland in the California Central Coast region are vulnerable to impacts from targeted grazing. The growth and reproduction of yellow star-thistle

(*Centaurea solstitalis*) have been negatively affected by targeted grazing with sheep, goats, and cattle. Targeted grazing methodologies for star thistle control have included high stocking rates for short periods of time at early stages of growth, before the star-thistle has a chance to bloom. Yellow star-thistle stands have been shown to be reduced most effectively when re-grazed at least once after an initial mid- to late-spring grazing application to remove regrowth, especially in years where late spring and early summer rainfall is higher than normal (Thomsen et al. 1993; Wallace et al. 2008).

Reduction of medusahead (*Taeniatherum caput-medusae*) has also been accomplished through targeted grazing. Targeted grazing methodologies for this species include use of sheep at a high stock density and for a limited duration (James et al. 2017). In the instances where this type of grazing has been effective in reducing medusahead cover, the plants were grazed in the mid-spring while in the 'boot' stage, before having the opportunity to flower. Grazing medusahead heavily during this brief window of time has been shown to dramatically reduce medusahead cover while allowing an increase in native species richness due to decreased levels of competition. However, this type of targeted grazing application could prove logistically difficult to accomplish for large stands of medusahead, due to the high stock density and narrow timing window necessary to achieve optimum results (DiTomaso et al. 2009).

Grazing to benefit wildlife and/or endangered species habitat

Increases in the populations of some wildlife species have been correlated with targeted grazing programs. When using targeted grazing methods to improve wildlife habitat, it is essential to obtain adequate information regarding the particulars of the preferred habitat of the

species in question. For example, kangaroo rats and meadow mice are both small mammals, but their different habitat preferences necessitate different targeted grazing strategies for improving their habitats. The grazier needs to increase stock density and duration of grazing in the kangaroo rat habitat to create the open areas the animal prefers for foraging, whereas decreasing stock density and duration of grazing is needed in the meadow mouse habitat to maintain enough vegetative cover to provide nesting and hiding sites (Barry 2011; Bush and District 2006).

The habitats of two amphibian species found within the Central Coast region—the California Red-legged Frog (*Rana draytonii*) and the California Tiger Salamander (*Ambystoma californiense*)—are commonly managed through the use of targeted grazing. The California Red-legged Frog is a federally threatened species that requires ponds with areas that are clear of extensive vegetative growth for successful tadpole development. Targeted grazing can reduce aquatic vegetation cover and thereby create suitable frog breeding habitat. The breeding activities of the California Tiger Salamander are often similarly dependent upon the existence of livestock stock ponds, especially when natural breeding areas such as vernal pools are absent. Targeted grazing can assist in the creation of suitable habitats for both species; however, continuous grazing of livestock in frog and salamander breeding areas can have a detrimental aspect effect on frog reproduction by disrupting egg masses. Where populations of these amphibians exist on traditionally grazed rangeland, such as in the East Bay Regional Parks, grazing at low to medium stock density is used until the late fall, when these species begin breeding. This practice limits damage to egg masses (Barry 2011; Bush and District 2006).

Grazing for fuel reduction/fire suppression

A frequent goal of targeted grazing is reduction of the potential for wildfires to carry across rangeland by reducing the amount of dry vegetation available to fuel the fires (Launchbaugh and Walker 2006). Although targeted grazing has not been shown to decrease the chance of fire ignition, it has been shown to reduce the speed and intensity of fire spread (McKenzie et al. 2011; Nader et al. 2007; Perevolotsky and Seligman 1998). This effect has been observed primarily in otherwise un-grazed areas at the fringes of urban zones in the San Francisco Bay Area where goats and sheep have been employed to consume quick-burning "fine fuels" (i.e., grasses). This application of targeted grazing may also serve to break up dense shrub growth, slowing potential fire spread by increasing distances between fuel sources (Bush and District 2006).

Grazing of native perennial grasses and forbs during the late-spring pre-flowering stage has proved to have detrimental effects on native plant stands because it decreases these plants' ability to compete with annual invasive species. Therefore, to avoid negative impacts on native grass and forb stands when using targeted grazing practices to reduce fuel loads, it is advised that stock density be kept at a low to moderate level during the pre-flowering stage, or that susceptible areas be grazed either before the perennial pre-flowering stage or during the plants' dormancy (Strand et al. 2014).

Key elements of a grazing plan

After identifying the resource management goal or goals to be accomplished through the use of targeted grazing, the management objectives related to livestock production, and the grazing methods to be used to accomplish the objectives and goals, and after this information is incorporated into a comprehensive goal statement, it is time to draft a grazing plan. A grazing plan will include all the elements just listed along with a description of a monitoring system for measuring progress in meeting the goals set down in the goal statement (Butler et al. 2003). Writing a comprehensive grazing plan with a feasible conservation goal requires knowledge of the characteristics of the site, the history of land use on the site, and how the grazing animals to be used will affect the site (Bush and District 2006; Butler et al. 2003).

Setting in place a system for monitoring and analyzing results is an essential part of the grazing plan process. Ranchers and land managers are accustomed to incorporating complex observational data into their management, but too often this process is confined to anecdotal evidence and does not involve the gathering, recording, and analyzing of data in a rigorous way. It can be challenging to collect data in a consistent and meaningful way over time, especially if the method is necessarily timely and complex, and it can be expensive. However, several relatively simply and easily implemented monitoring methods exist. Photographic monitoring can be the simplest way to collect data measuring changes in forage cover or vegetation type for many ranchers and land managers (Woods and Ruyle 2015). Another commonly used monitoring method is recording residual dry matter (RDM), the measurement of plant material left standing on the ground in the fall, immediately prior to the commencement of the first seasonal rains prompting regrowth. Depending on average precipitation, the amount of woody cover on a site, slope, and other factors, the recommended amount of RDM varies. Where RDM

recommendations are followed, researchers have observed higher protection from soil erosion, increased forage productivity, and higher levels of species diversity in the year following adherence to the recommendation (Bartolome et al. 2007).

RDM measurements can be useful for monitoring the impacts of targeted grazing techniques; making progress toward meeting different management goals, such as improving wildlife habitat or reducing wildfire fuels, can be indicated by different amounts of RDM. When multiple conservation goals exist and necessitate different targeted grazing applications, one conservation goal may have to periodically be given priority over another. For example, the minimum level of residual dry matter that must remain after grazing to provide adequate nesting habitat for small birds and mammals may be higher than the recommended minimum RDM for reducing the threat from wildfire or supporting larger mammals such as kangaroo rats that require low levels of vegetative cover (Allen-Diaz and Jackson 2005).

When attempting to quantify the effects of a targeted grazing practice on the presence of a key species (either desired or undesired), it is also common to establish sampling plots within a larger area of rangeland within which plant stand density, species composition, and other vegetative attributes can be measured. When establishing this kind of monitoring, it is critical to select and maintain permanent long-term sampling plots, with plots large enough to provide an accurate sample of the target species in relation to the area being studied, but not so large as to make sampling excessively difficult or time-consuming. More diverse areas of vegetation may require an increased number of plots to provide sufficiently representative data (Woods and Ruyle 2015).

Targeted grazing in practice in the Central Coast region

To further examine the prevalence and implementation of targeted grazing systems within the Central Coast region of California beyond what information can be found in the published literature, fifty-two ranchers, academics, and agency personnel belonging to the Central Coast Rangeland Coalition were surveyed. When asked which resource management goals they would like more information about because of interest in realizing those goals through targeted grazing, survey respondents most frequently mentioned creating and maintaining riparian areas (84.3% of respondents), increasing the presence of native grasses (82.4%), controlling noxious weeds (80.4%), improving wildlife habitat (78.4%), increasing the presence of native forbs (74.5%), improving endangered species habitat (70.6%), and reducing fuel loads to suppress fires (52.9%) (Figure 1).

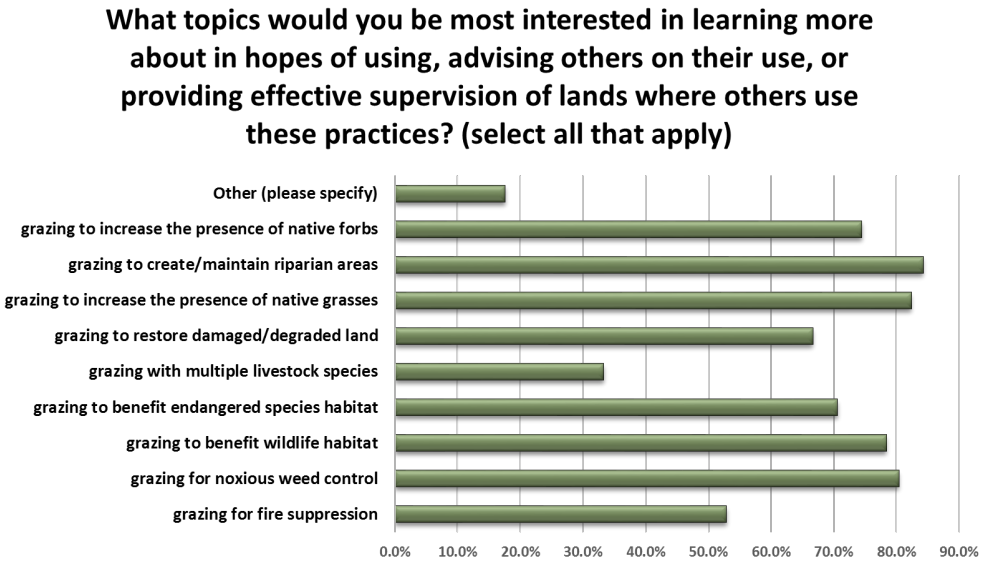

Figure 1. A survey of Central Coast Rangeland Coalition members conducted via Survey Monkey in March 2017 – answers in the category of 'other' which could not be categorized within the other options included grazing to improve soil health and increase carbon sequestration.

When survey respondents were limited to managers, ranchers, and agency personnel who are currently using targeted grazing practices to address resource management goals, their responses showed that over half have a written grazing plan of some kind, with three-quarters of those grazing plans containing clear goals and objectives for the grazing program. However, fewer than half of those grazing plans also outline some method of measuring progress toward meeting the desired resource management goals (Figure 2). (Respondents were not asked which monitoring methods they were currently using or had used in the past.) From these responses, it can be determined that those surveyed face challenges in monitoring results and attempting to judge the success of a targeted grazing system.

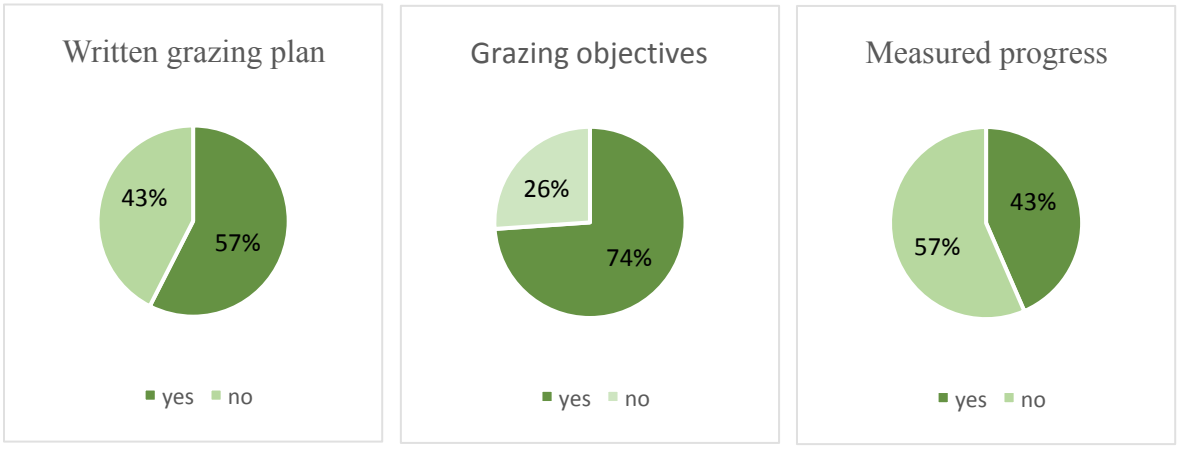

Figure 2: Quantified answers to the survey question: Do you have a written plan for the grazing practices that you use or advise others to use, or that are used on lands that you supervise? (If so, please describe that document: does it include objectives/goals that you are hoping to meet with these grazing practices and ways to measure your progress toward those goals?)

When asked to identify the main challenges they faced when attempting to implement a targeted grazing program, respondents cited logistical problems or lack of infrastructure (51% of respondents), cost (42%), preconceived ideas or biases about targeted grazing (22%), lack of knowledge or available information (20%), and the conflicting needs of livestock producers and agency personnel (13%).

To explore these survey results in more depth and to gauge the effectiveness of several targeted grazing systems currently in place in the Central Coast region, site visits and in-person interviews were conducted at five sites within Santa Cruz and Santa Clara counties. Each of these sites is currently under the management of personnel adhering to detailed grazing plans, which were made available for review.

Glenwood Open Space Preserve, Santa Cruz County

Glenwood Preserve is a 166 acre preserve owned by the city of Scotts Valley and managed by the Land Trust of Santa Cruz County, which holds a conservation easement on the property. The preserve provides habitat to several rare species, most notably the federally endangered Ohlone Tiger Beetle (*Cicindela ohlone*), which has only been observed in parts of Santa Cruz County. The targeted grazing plan for this site naturally focuses on maintaining habitat for this species, as well as the federally endangered Scotts Valley spineflower (*Chorizanthe robusta* var. *hartwegii*) and federal species of concern Opler's longhorn moth (*Adela oplerella*). Each of these species has habitat needs which are conducive to those found in historically native perennial grasslands grazed by cattle. The Ohlone Tiger Beetle requires relatively flat areas of bare or sparsely vegetated soil for its larva burrows and is often seen along cattle trails and the edges of stock ponds. Similarly, the Scotts Valley spineflower benefits best from the decreased competition from other vegetative species seen in more sparsely vegetated areas, as do cream cups (*Platystemon californicus*), the main food source for the larva of the Opler's longhorn moth (Amme 2003).

To facilitate the establishment of beneficial habitat for these species, the Glenwood Preserve has been subdivided into five pastures and grazed by cattle, with emphasis based on excluding cattle from individual pastures as necessary throughout the year. Specifically, for establishment and maintenance of Ohlone Tiger Beetle habitat, an ideal grazing plan for the preserve recommends exclusion of cattle from wetter pastures during the winter months in order to avoid potential compaction damage to burrows housing eggs and larvae. Limited access to the most productive pastures is recommended when RDM levels in other fields fall below the recommended limits for maintenance of native grass stands. Areas exhibiting a large concentration of Ohlone Tiger Beetle burrows may also be weed-whacked if necessary to control vegetative growth (Arnold et al. 2012).

University of California, Santa Cruz

Inclusion Area A, a pasture on the UC Santa Cruz campus dominated by swales causing significant run-off in places, also contains cattle trails as the result of historical cattle grazing that have proven to be sufficient habitat for the Ohlone Tiger Beetle. To maintain habitat for this species, it was recommended in 2013 that cattle grazing begin earlier in the spring and be conducted at higher stocking rates than in the past, while also encouraging biking and walking traffic to maintain bare ground observes on trails within the pasture. Weed-whacking and scraping to expose bare soil was also recommended if deemed necessary to increase available habitat. It was recommended that areas of Ohlone Tiger Beetle habitat be excluded from cattle grazing for the majority of the year during the summer, fall, and winter months, to limit potential grazing stress on native grass stands. Similar grazing recommendations were made to promote an improvement in habitat quality for the federally threatened California red-legged frog (*Rana*

draytonii), a species which had not been observed on the site at the time but could still potentially be found in the area in the future (Ford and Arnold 2013).

Santa Teresa County Park, Santa Clara County, CA

Santa Teresa County Park contains habitat beneficial to a large number of special-status or sensitive species, including twenty vertebrate species and four invertebrate species, most notably the Bay Checkerspot Butterfly (*Euphydryas editha bayensis*). The Bay Checkerspot Butterfly is reliant on California plantain (*Plantago erecta*) as a food source, which is commonly outcompeted by annual grasses in the absence of grazing pressure. To help facilitate the complicated nature of attempting to maintain beneficial habitat for the large number of special-status species present on the site, the Santa Teresa County Park Grazing Plan contains detailed recommendations for cattle movement and exclusion within the park, managed by cattle rancher Allen Renz and based on yearly grassland conditions, taking fluctuations in precipitation and forage production levels into account.

Within the approximately 900 grazable acres of the park, there exist multiple areas which must be managed differently from each other, due to the presence of special-status species, undesirable invasive plants, or wet areas susceptible to compaction necessitating more exclusion from cattle grazing. For these reasons, it was recommended in 2011 that the park be subdivided into seven distinct grazing fields. These fields were classified into three groups of varying management priority, ranging from Serpentine Habitat Fields, which receive the highest management priority and contain habitat for Bay Checkerspot Butterfly and other special-status species; to Wildlife Habitat Fields, managed primarily for other special-status animals besides

the Bay Checkerspot Butterfly and designated as the second highest priority for management; and Auxiliary Fields, given the lowest priority for management due to an absence of suitable special-status species habitat. However, as of 2017, the infrastructure has only been supplied to fence four of these pastures: two Serpentine Habitat Fields and two Auxiliary Fields (Ford and Group 2011).

Star Creek Land Stewards, Merced County, CA

Based in Los Banos but operating throughout the Central Coast region, Star Creek Land Stewards is a contract-grazing operation that provides services to private landowners, businesses, and public organizations. The operation was originally composed of mainly sheep herds, but switched to goats for their versatility and hardiness. The main resource management goals addressed by the operation is fuel management to reduce fire risk, but they have also been contracted to control invasive species, especially star thistle. Notable agencies which have contracted with Star Creek include the Santa Clara Open Space Authority, Santa Clara County Parks, and Cal Fire. Owner Andreé Soares notes that most agencies easy to work with, but completely unknowledgeable regarding the biological capabilities and needs of grazing livestock, requiring that each new contract be discussed in detail with responsible agency personnel before committing to a project (Soares 2017).

Since 2014, Star Creek has grazed sheep and goats on land within the Redwood Regional Park Serpentine Prairie, managed by the East Bay Regional Park District (EBRPD). The EBRPD seeks to increase the biological diversity with the prairie and especially to increase the presence of the federally-endangered forb Presidio clarkia (*Clarkia fransiscana*). Goats and sheep were deemed optimal for this project to provide low levels of ground disturbance and remove annual

grass cover while ensuring little chance of damage to Presidio clarkia that may have resulted from the heavier grazing pressure applied by cattle grazing (Naumovich 2016).

Justin Fields, Santa Clara County, CA

Justin Fields, a fourth-generation cattle rancher, owns approximately 200 acres in Morgan Hill, California, but also grazes large swaths of public land managed by local public agencies. As most of the land he grazes is connected, he has the flexibility to practice targeted grazing with the purpose of increasing wildlife habitat. Fields attributes his ability to effectively cooperate with agency workers to the close relationships he has formed by avid participation in local boards and committees; at the same time he expresses concern about the loss of those close working relationships as the agencies expand the number of personnel involved with targeted grazing projects (Fields 2017).

Of particular interest are several parcels managed by the Santa Clara Valley Open Space Authority and grazed by Fields' cattle. Tulare Hill has been managed for the preservation of habitat for Bay Checkerspot Butterfly and Opler's longhorn moth, as well as the federally endangered Santa Clara Valley dudleya *(Dudleya abramsii* ssp. *setchelli)*. Coyote Ridge has also been managed for the maintenance of Bay Checkerspot Butterfly habitat and for the Santa Clara Valley dudleya, as well as for most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*). Populations of most beautiful jewelflower and the Santa Clara dudleya have both responded positively to moderate levels of grazing pressure; the grazing has reduced grass competition and created bare soil to allow these forbs, as well as forbs which are fed upon by the Bay Checkerspot butterfly and Opler's longhorn moth, to better compete with annual grass species (Quenelle et al. 2017).

Issues faced by site managers

Each of the sites examined is located in close proximity to highly populated areas, a trait fairly common to rangeland throughout the highly developed Central Coast region. Land managers at the sites reported that proximity to urban areas has resulted in several unforeseen setbacks to their grazing plans. Most notably, managers reported difficulty maintaining fence lines, which are often cut by itinerant individuals seeking campsites and access to water at the livestock watering troughs. Currently, the most effective way of solving this problem appears to be to provide multiple pass-through points or "step-overs" near areas of the fence line which have commonly been cut for access. Gates being left open by people using public lands for recreational use is also a concern.

Land managers at each site also expressed concerns regarding their abilities to continue long-term targeted grazing programs over time when faced with possible future decreases in funding. This was most clearly demonstrated at Santa Teresa Park, where lack of fencing has inhibited the ability to graze large areas of the park, and at the University of California, Santa Cruz, where monitoring efforts, which were quite extensive initially in 2013, were close to nonexistent by 2017. Again, this is indicative of the lack of available long-term funding for targeted grazing projects.

Each targeted grazing practitioner stressed the necessity of continuous honest and open communication among land managers, livestock producers, and agency personnel involved in cooperative targeted grazing projects. Each livestock producer also insisted that the producers' ability to be flexible and adapt to changing climatic factors and agency re-structuring were key factors in the success of targeted grazing programs. Producers noted that because livestock

production was their top priority, they would not be able to complete the proper documentation and perform the necessary monitoring essential to the functioning of a successful targeted grazing system without the cooperation of agency personnel and land managers.

Conclusions

Although interest in research on the practice of targeted grazing on the California Central Coast has risen greatly over the last couple of decades, there still exists a lack of cohesive terminology when referring to the practice. These discrepancies are particularly evident among government and private agencies, although many researchers also express preferences for particular terms. When many terms are used interchangeably to refer to similar concepts, or one concept can have varying definitions, this can necessitate extensive explanation of terminology, as evidenced in this paper, before an author can commence the process of classifying similarities and differences between targeted grazing systems.

When attempting to assess the success of various targeted grazing practices in meeting their resource management goals, several factors consistently come into play throughout most research studies. It seems evident that a successful targeted grazing application must be encompassed within a comprehensive grazing plan that identifies a goal or goals, accurately identifies the best methods to be used to meet that goal or goals, identifies specific measurable performance standards for monitoring, investigates the ecosystems involved, and includes an appropriate monitoring system to collect and analyze results. The main challenges to researchers who have not been able to come to conclusions regarding the effectiveness of targeted grazing treatments, even within generally climatologically consistent areas of the California Central

Coast region, lie in the characteristics endemic to most research studies. Notably, research studies tend to be short in nature, lasting only a few years at most, with methodology repeated without adaptation during each phase or year of the study. Because rangeland ecosystems are generally accepted to change very slowly over time, short-term studies cannot easily capture the effects of interventions. Serious gaps between research goals and land manager goals also exist in that effective rangeland management also often necessitates that land managers adapt their management techniques from year to year as dictated by varying climatological factors including temperature and rainfall (Boyd and Svejcar 2009). To truly evaluate the effectiveness of grazing systems using targeted grazing techniques on rangeland and the potential benefits they may have for land managers and ranchers, there is a need for long-term research that takes environmental aspects and the need for adaptive management into consideration.

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