Effectiveness of nutrient supplement placement for changing beef cow distribution

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Abstract: Assessments of conservation effects are being conducted to determine the effectiveness of agricultural conservation practices. The practice of nutrient supplement placement to improve livestock distribution has not been designated a "best management practice" by the USDA Natural Resources Conservation Service (NRCS). Three studies in California visually and statistically document the effectiveness of nutrient supplement placement for changing livestock distribution. The initial study conducted in the Sierra Nevada foothills demonstrated that use of riparian patches could be reduced with strategic placement of dehydrated molasses supplement. A study on an adjacent ranch found that during the dry season, supplement placement effectively redistributed livestock by attracting them into a zone that extended out to about 600 m (1,980 ft) from the supplement. In a study on a coastal ranch in San Luis Obispo County, nutrient supplements were used to attract cows into an ungrazed forest adjacent to grazed grassland. The results of the studies reported here support the effectiveness of supplement placement for changing livestock distribution. Integration of supplement placement practices into best management practices and into NRCS's prescribed grazing standard is supported by this research.

Key words: grazing—livestock distribution—supplement placement

Livestock grazing issues on rangelands are often the result of uneven distribution rather than over-stocking (too many animals). Correcting the effects of poor livestock distribution is often the conservation goal of "best management practices" applied to grazing lands. While water developments and fencing are common grazingland best management practices, other livestock distribution practices such as the use of nutrient supplements to attract livestock away from environmentally sensitive areas or into target areas have not been designated to be "best management practices."

Most commercially available protein supplements contain molasses (and thus are very palatable) and have the potential to attract animals into underused areas of a pasture. However, few studies have evaluated the effectiveness of supplement placement for improving livestock distribution (Bailey and Welling 2007). While it is common knowledge among ranchers and rangeland managers that placement of salt, hay, protein and other nutritional supplements can influence livestock distribution, citizens' advisory groups and regulatory agencies are less certain of their effectiveness.

Improved livestock distribution is crucial to sustainable grazing management (Vallentine 2001). Concentration of grazing in areas, such as riparian zones, preferred by livestock can result in adverse impacts on forage production, water quality, wildlife habitat, and other ecosystem goods and services. The purposes of the prescribed grazing practice in the USDA Natural Resource Conservation Service (NRCS) *Field Office Technical Guide* (USDA NRCS 2006) are to (1) improve or maintain the health and vigor of plant communities, (2) improve or maintain quantity and quality of forage for livestock health, (3) improve or maintain water quality and quantity, (4) reduce accelerated soil erosion and maintain or improve soil condition, (5) improve or maintain the quantity and quality of food and/or cover available for wildlife, and (6) promote economic stability through grazing land sustainability. Supplemental feeding is included in the prescribed grazing practice but only to meet desired nutritional levels with the admonition that placement of supplemental feed should not result in negative impacts to soil, water, air, plant, and animal resources. Assessment of the effects of conservation practices used on agricultural lands and grazinglands is ongoing but does not include nutrient supplement placement (Kannan et al. 2005; Maderik et al. 2006). Previous studies (McDougald et al. 1989; Bailey and Welling 1999) suggest that supplement placement is an effective practice for attracting livestock into areas where grazing is desired and keeping livestock away from environmentally critical areas such as riparian zones.

The purpose of this report is to provide visual and statistical evidence, from on-ranch studies in California, of the effectiveness of nutrient supplement placement for attracting beef cows away from overused areas and into underused areas of large pastures. Our objectives were to (1) demonstrate that beef cows could be attracted away from riparian patches into underused upland areas, (2) demonstrate that beef cow positions would increase near supplement points when supplement was present and would decrease when the supplement was removed, (3) document changes in beef cow distribution within 1,000 m (3,300 ft) of the supplement points, and (4) demonstrate that supplements could be used to attract cows into areas previously avoided.

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Figure 1
Beef cows equipped with global positioning system collars at a supplement site on ranch C.

Figure 2
Location of on-ranch studies of supplement placement in California's annual rangelands.

Methods and Materials

From 1997 to 2004, on-ranch case studies of the influence of nutrient supplement placement (figure 1) on beef cow distribution were conducted at three locations in California. Ranch A and ranch B are in Madera County, and ranch C is in San Luis Obispo County (figure 2). In each case study, the experimental design was adapted to the normal routine of the ranch operation so that we could determine the effectiveness of this practice under normal ranch conditions. The normal routine on each ranch was to rotate cattle to new pastures as needed to prevent over-stocking and to accommodate animal management practices.

Ranch A. In July 1997, we determined positions of 15 beef cows every 15 min for 24 hr in a 75 ha (188 ac) pasture with and without supplement at ranch A. This oak-woodland pasture is in the Sierra Nevada foothills of Madera County about 30 km (18.6 mi) north of Fresno, California. During daylight hours cow positions were videotaped every 15 min. At night, observers marked cow positions directly on aerial photographs. Without supplement, cattle positions were determined for 24 hrs three days after cows were placed in the pasture. Supplement was then placed in the pasture, and cattle positions were determined six days later for a 24-hr period (figure 3). Using the global positioning system (GPS) positions of the videographer and GPS positions of permanent objects in the videotapes, daylight cow positions were later mapped in a geographic information system (GIS). Night positions were digitized in the GIS from the aerial photographs.

Ranch B. This study was conducted in an oak-woodland pasture in the Sierra Nevada foothills of Madera County about 25 km (15.5 mi) north of Fresno, California. Beef cow positions were recorded for 5 to 8 cows grazing in a herd of 40 to 70 cows. Positions were recorded every 15 min for 25 to 30 d using global positioning collars. On day 1, the cows were placed in a 193 ha (482 ac) oak-woodland pasture with no supplement treatment. On day 3, supplement was placed 381 m (1,257.3 ft) from stockwater at site A for five days, then the supplement was moved to site B (746 m [2,461.8 ft] from water) for five days, followed by site C (1,081 m [3,567.3 ft] from water) for five days (figure 4). Supplement was then removed for five days (control) before ending the trial.

This study was repeated in November 2001 (fall), July 2002 (summer), November 2003 (fall), and February 2004 (winter). Cow positions for the middle three days (days 2 to 4) of each supplement treatment were compared to cow positions when no supplement was available at the end of each seasonal study. Paired comparisons (t-tests) were used to test for differences in cow positions between each supplement treatment period and the untreated period. Treatment pairs were compared at 50-m (165-ft) intervals to 1,000 m (3,300 ft) from the center of the supplement sites. Residuals for each supplement location treatment were pooled over distance intervals and tested using the Shapiro-Wilk Test for normality. The Shapiro-Wilk test ranged from 0.94 to 1, indicating that the residuals were normal or nearly normal.

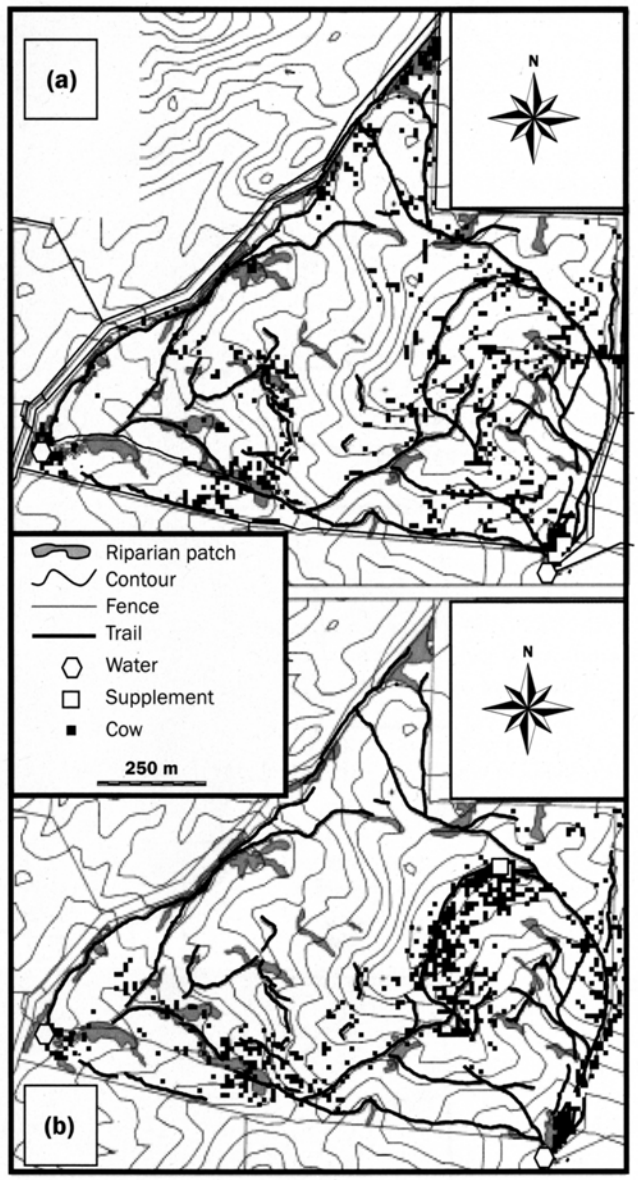
Ranch C. In August 2004, the percentage of beef cow positions within 100, 300, and 600 m (330, 990, and 1,980 ft) of coastal grassland and forest supplement sites were compared with and without supplement on ranch C. Eight beef cows in a herd of 70 cows were equipped with GPS collars and positions were collected every 15 min for 21 d. One week after turning the cows into a 400 ha (1,000 ac) pasture, supplement was placed in the grassland at site A for one week (figure 5). The following week supplement was placed in the adjacent forest at site B.

Lotek GPS collars of the 2200 LR and 3300 LR Series were used on ranches B and C (Lotek Engineering, Newmarket, Ontario). The positions downloaded from the GPS collars were differentially corrected with typical accuracy of within 2 m (6.6 ft) (Unger et al. 2005; Smith 2006) using base station files from the Mammoth Community Water District in Mammoth, California. This station was used because it was the nearest station that was operational for 24 hr d^{-1}.

Results and Discussion

Ranch A. In July 1997, the study pasture at ranch A was characterized by a series of riparian patches that remained green after the surrounding upland understory vegetation had dried (figure 3). Without supplement, the cows made a daily circuit of the riparian patches resulting in the 24-hr distribution in figure 3a. When supplement was placed on a ridge-top on the east side of the pasture, the daily circuit of the riparian patches ceased and animal positions were concentrated in the vicinity of the supplement site (figure 3b). Direct observation of time spent grazing indicated that when supplement was absent 37% of grazing occurred in the seasonal riparian areas, decreasing to 14.5% when supplement was present.

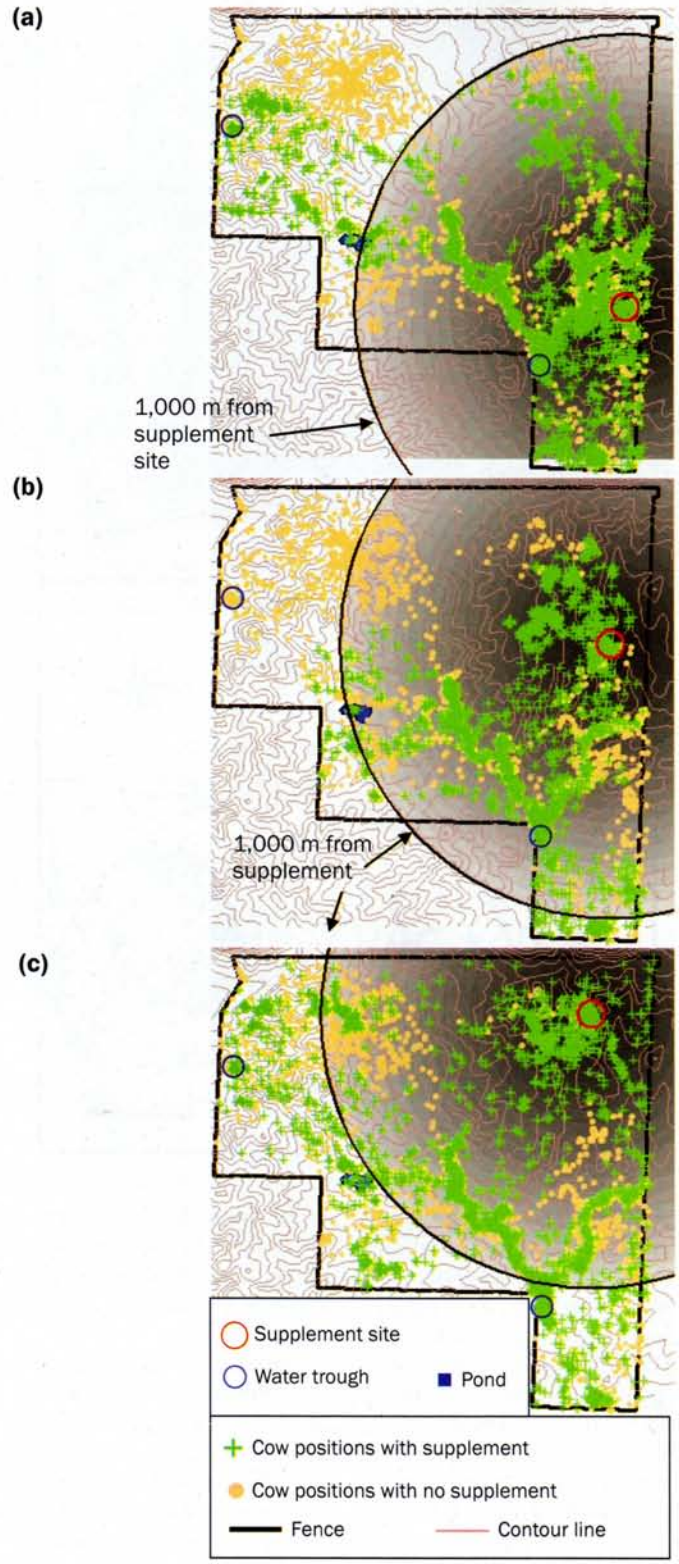
Figure 3
(a) Location of riparian patches, positions of cows without supplement, and (b) positions of cows with supplement at ranch A in July 1997.



Ranch B. The presence of supplement in the ranch B pasture significantly increased ($p < 0.05$) the proportion of livestock positions within 50 m (165 ft) of the supplement points at all distances from water and for all four trials (figure 6). Three of the trials (November 2001, 2003, and July 2002) were conducted during the dry season when protein supplementation is a normal range livestock management practice. The February 2004 trial was conducted during a period when high quality green forage was available in adequate amounts throughout the pasture.

During the November 2001, July 2002, and November 2003 trials, the presence of supplement strongly influenced cow location. Distributions during the July 2002 trial are presented in figure 4 as an example. During the November 2001 and 2003 trials, the percentage of cow positions in most 50-m (165-ft) intervals out to 600 m (1,980 ft) was significantly greater when supplement

Figure 4
Positions of cows when supplement was present and not present at three distances from stock water in an oak-woodland pasture on ranch B in Madera County, California.

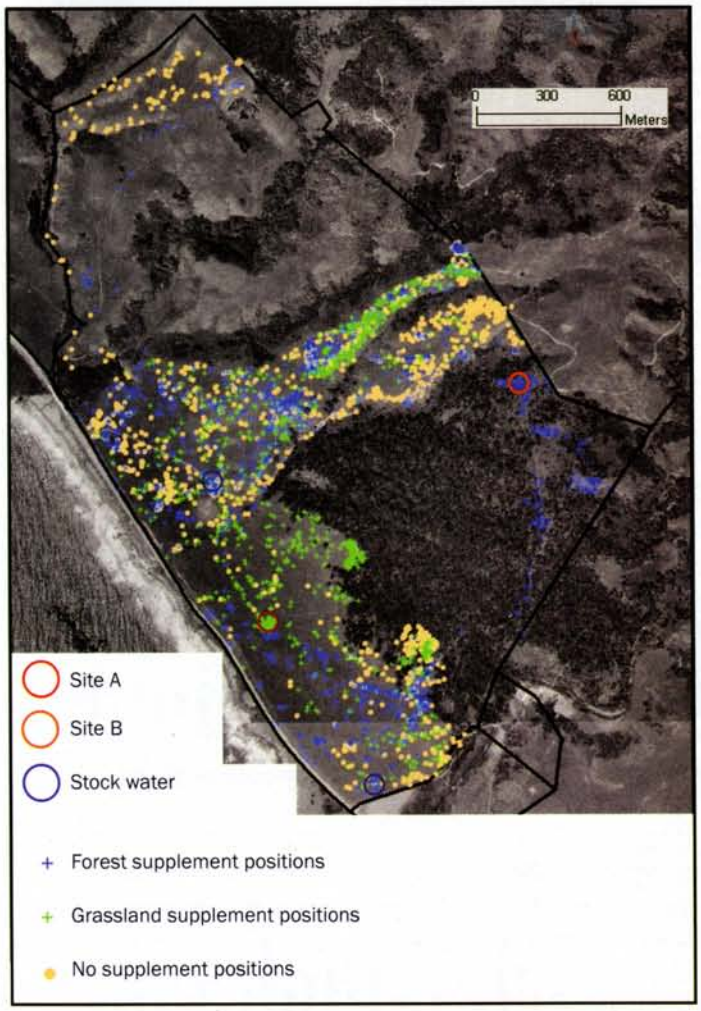


was present than when it was absent (figure 6). Similar results were observed for sites B and C during the July 2002 trial. However, comparisons of cow positions for supplement site A in July 2002 were not significantly different at 100 m (330 ft) through 600 m (1,980 ft) intervals from the supplement point (figure 4a). Stockwater and shade trees are within the 100 to 600 m zone around site A. Thus, this area remained attractive to cattle even when the supplement was removed resulting in no significant difference in the proportion of cow positions with or without supplement. In addition to the supplement provided in the study treatments, the ranch provided a liquid supplement which was a strong attractant in the northwest quadrant of the pasture when treatment supplement was not present (figure 4).

During February 2004, when forage was green and of higher quality, the proportion of livestock positions within the 50 m (165 ft) interval were significantly greater when supplement was present. At site A, most paired comparisons for the intervals from 100 to 1,000 m (330 to 3,300 ft) were not significantly different or cow positions were greater when supplement was not present. At site B, paired comparisons at the 150 and 200 m (495 and 660 ft) interval were significantly greater when supplement was present, but the comparisons for the remaining intervals were not significantly different or the percentage of cow positions was greater when supplement was not present. Few of the paired comparisons for site C were significantly different. In three cases, the percentage of cow positions was greater without supplement. These results suggest that beef cows were indifferent toward the supplement when there was adequate high quality forage.

During the dry season, there appears to be a zone of influence around a supplement site that extends 400 to 600 m (1,312 to 1,980 ft) from the supplement (figure 4). At distances beyond 600 m, the influence of supplement placement is no longer effective, and cow positions without supplement may be significantly greater than with supplement (figure 6). These results are similar to those of Bailey et al. (2001), where cows equipped with GPS collars spent 16% of their time within 200 m (660 ft) of supplement and 33% to 40% of their time within 600 m of the supplement sites. In the ranch B pasture, there were other attractants including three watering

Figure 5
Positions of cows when no supplement is provided and when supplement is placed at site A (grassland) or site B (forest) on ranch C in San Luis Obispo County, California.



points, a liquid supplement tank during the dry season, evening hay feeding areas during the November trials, and patches of green forage and shade trees in July. Despite these other attractants, the dehydrated molasses supplement remained a strong attractant.

Ranch C. Supplement placement was also found to be an effective attractant on ranch C. In the summer of 2004, supplement was placed in an open grassland (site A) along the western edge of a 400 ha (1,000 ac) coastal pasture for one week and then was moved to an adjacent forest (site B) for one week (figure 5). When supplement was placed at site A the proportion of positions within 100, 300, and 600 m (330, 990, and 1,980 ft) was 10%, 16%, and 49% of all positions, respectively. Without supplement, there were no positions within 100 m of the grassland supplement site, 7% of positions were within 300 m, and 18% were within 600 m of the grassland supplement site. When supplement was placed in the forest adjacent to the grassland, 14%, 17%, and 40% of all positions were within 100, 300, and 600 m, respectively. When supplement was removed from the pasture, there were no positions within 300 m of the former forest supplement site, and only 2% of positions within 600 m of the forest supplement site.

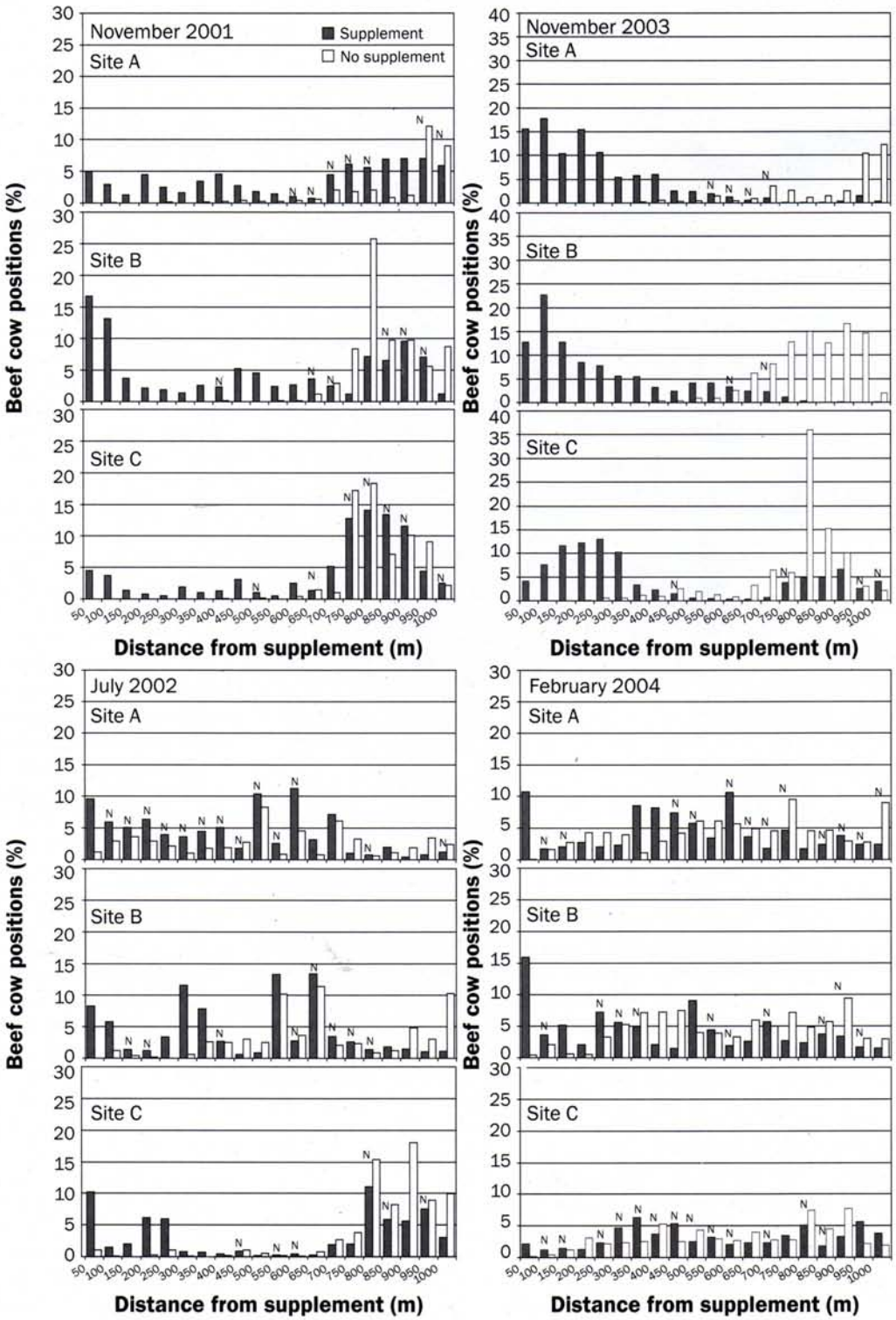
The grassland along the western half of this pasture is on gentle terrain and receives the majority of the grazing use. While the cows use the forest edge for shade (figure 5) they rarely venture into the forest. The ranch manager wanted to reduce understory fuel load by grazing the forest. The results of this study demonstrate the effectiveness of supplement for attracting beef cows into the forest.

The results of these on-ranch studies and research elsewhere in the west are important because they demonstrate that supplement is a strong attractant that can alter distribution of beef cattle and, more importantly, that it can reduce the time beef cows spend in riparian areas. Direct observations during these California studies confirm that the cows were grazing in the area of the supplement. Theses results are similar to those of Bailey et al. (2001) who found that cattle spend more time and graze more forage within 600 m (1,980 ft) of supplement sites. Placement of hay can also be used to manipulate distribution patterns of livestock and reduce grazing in riparian areas (McDougald et al. 1989). Bailey and Welling (1999) found that low-moisture molasses supplement blocks were more attractive than salt for luring grazing animals into areas that are rugged or distant from water. In a New Mexico study, low-moisture blocks were more effective than pressed blocks for manipulating cattle grazing patterns (Bailey 2003). In a Montana study, grazing patterns of cows fed range cake (supplement cubes) in accessible terrain were compared to cows fed low-moisture blocks placed in higher terrain that would not normally be accessible for feeding range cake (Bailey 2003). Cows fed low-moisture blocks used higher elevations ($p = 0.06$) than cows fed range cake. Although cows readily travel to the areas where cake is fed, they did not stay in the area after the supplement was consumed. Cows that were fed low-moisture blocks (self-feeding) spent almost 5 hr d^{-1} within 100 m (330 ft) of the feeding site, whereas cows fed range cake spent less than 1 hr (Bailey and Welling 2002).

Attracting livestock away from critical areas is not the only opportunity presented by supplement placement. Maintaining habitat for endangered species such as the Bay checkerspot butterfly (*Euphydryas editha bayensis*) requires targeted grazing levels in specific areas (Weiss 1999). With decreasing use of chemicals and fire for managing weeds, grazing for weed control is becoming more important. Targeted grazing of weed populations such as medusa-head (*Taeniatherum caput-medusae*) and yellow-starthistle (*Centaurea solstitialis*) can be facilitated by strategically timed application of grazing treatments (George et al. 1989; Thomsen et al. 1993). Ongoing studies

Figure 6

Paired comparisons of beef cow positions at 50-m intervals within 1,000 m of supplement locations A, B, or C with and without supplement for fo trial dates (November 2001, July 2002, November 2003, and February 2004) on ranch B in Madera County.



Note: Paired comparisons that are not labeled "N" are significantly different ($p < 0.05$).

demonstrate that supplement placement can be used to impact medusahead populations (Doran et al. 2004).

Summary and Conclusions

It is crucial to sustainable range livestock production that managers manipulate livestock distribution to meet production and conservation goals. Attracting livestock away from critical areas and into underused areas of pastures requires innovative management and an understanding of livestock grazing behavior. While fences and water developments strongly influence livestock distribution, they are not the only tools available to the manager. The results of these studies demonstrate that strategic placement of supplement can be an effective tool for altering livestock distribution during the dry season. When green forage is adequate, the supplement sites are less attractive. When supplement is placed in rangeland pastures or allotments, cattle not only congregate at the supplement site but they graze and rest in adjacent areas within 600 m (1,980 ft) of the supplement site. Thus, supplements can reduce grazing in riparian patches and can attract cattle away from areas around stockwater troughs. In these studies, cattle were attracted more than 1.3 km (0.806 mi) from stock water. The results of the studies reported here and elsewhere in the west support the effectiveness of supplement placement for changing livestock distribution. Integration of supplement placement practices into "best management practices" and into NRCS's prescribed grazing standard is supported by this research. Recognizing that livestock response to supplement placement is dependent on abiotic and biotic characteristics unique to each grazed landscape, we propose that supplement placement be integrated into prescribed grazing systems and evaluated in a variety of rangeland and pasture systems and landscapes. These evaluations could be completed with funding from the NRCS Conservation Innovation Grants program. During these studies, the effectiveness of single, multiple and rotating supplement sites could be evaluated for attracting cattle away from environmentally critical areas or into target areas such as weed infestations.

While supplement placement has a strong influence on beef cow distribution, it must be integrated with fencing, water development, and other practices to accomplish grazing management goals. Fencing and water development are time-tested methods of controlling or manipulating livestock distribution. Supplement placement is not a substitute for strategic placement of water developments and fences, but it can help managers fine-tune distribution beyond that achieved with other practices. Nutrient supplementation increases operational costs of range livestock operations but is often necessary during part of the year to maintain adequate nutrient intake. Strategic placement of these supplements can attract livestock into under-used portions of rangeland pastures, thus increasing the benefits from a cost that is often already being incurred.

This practice, precision supplemental feeding, could also be used in the context of precision conservation. The latter refers to using spatial technologies such as GIS to implement conservation practices taking into account landscape and temporal variability in order to improve environmental outcomes (Berry et al. 2003, 2005). For example, careful placement of supplements could be used to target grazing and manure deposition to areas that are further from water bodies, or which are less likely to have nutrient runoff during rainfall events. We propose that by precisely placing nutrient supplements based on management decisions that consider economic returns and environmental and site-specific factors, we could contribute to precision conservation of soil and water.

Because supplement is so attractive, prolonged use at a single location could result in heavy utilization of vegetation near the supplement, increased bare ground that may lead to soil erosion, and reduced infiltration rates just as may occur around permanent water troughs and along frequently used trails (Tate et al. 2004). Unlike liquid supplement tanks, low moisture blocks, hay, and other transportable supplement forms can be moved as needed to prevent degradation of supplement sites.

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