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Guidelines for Residual Dry Matter on Coastal and Foothill Rangelands in California

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Residual dry matter (RDM) is a standard used by land management agencies for assessing the level of grazing use on annual rangeland and associated savannas and woodlands (George et al. 1996). RDM is the old herbaceous plant material left standing or on the ground at the beginning of a new growing season. It indicates the combined effects of the previous season's forage production, breakdown over summer, and its consumption by grazing animals of all types. The standard assumes that the amount of RDM remaining in the fall, subject to site conditions and variations in weather, will influence subsequent species composition and forage production.

Properly managed RDM can be expected to provide a high degree of protection from soil erosion and nutrient losses. Applications of specific RDM standards based on a limited research base and on experience have demonstrated the effectiveness of this approach to grazing management. Because of the limited amount of research information, standards and score cards normally have to be developed using local experience and general guidelines such as those that appear in this publication. Numerous agencies have successfully applied the RDM-based method for managing grazing intensity over the past 20 years. Some examples are the Bureau of Land Management and the Natural Resources Conservation Service (BLM 1999), the National Park Service (Shook 1990), the U.S. Forest Service (USDA Forest Service 1997), and the San Joaquin Experimental Range (Frost et al. 1988).

REGIONAL GUIDELINES

A series of experiments conducted by H. F. Heady dating from the 1950s showed that the amount of fall RDM (or what Heady termed "natural mulch") dramatically influenced forage productivity and composition at the high-rainfall (35 in/yr, or 89 cm/yr) UC Hopland Research and Extension Center site in southern Mendocino County (Heady 1956). To determine the effects of RDM that would be representative of heavy to moderate grazing on annual rangeland at different sites, Heady established nine experimental plots in the late 1960s and early 1970s and maintained them for 3 to 5 years. They were arranged along a rainfall gradient from the North Coast (rainfall > 40 in/yr, or 102 cm/yr) along the west side of Central Valley to the driest annual rangeland in the Western San Joaquin Valley (rainfall < 7 in/yr, or 18 cm/yr) (Bartolome et al. 1980).

This study showed that RDM had a significant influence on rangeland productivity in areas with annual rainfall in excess of 15 inches (38 cm/yr), subject to the overriding controls of site conditions and annual weather. Maximum productivity within the 15- to 40-inch (38- to 102-cm) annual precipitation zone occurred with 750 pounds per acre (840 kg/ha) of RDM in fall. The effects on composition in Heady's experiment were mixed (Jackson and Bartolome 2002). However, the experimental sites constituted an incomplete representation of the annual rangeland region and were limited to flat ground without any woody plant cover. An ongoing experiment in the Sierra Foothills suggests that the range of 600 to 1,200 pounds per acre (672 to 1,344 kg/ha) of RDM maximizes both forage production and species richness (Bartolome and Betts 2005).

UC PEER REVIEWED

Clawson et al. (1982) developed regional guidelines for minimum allowable RDM based on the best available research information at the time. Subsequent experience and limited research suggest that those guidelines for RDM were probably too low for grasslands with more than about 12 inches (31 cm) of average annual precipitation. McDougald et al. (1991) developed a scorecard that can be used to quickly estimate an area's grazing capacity. The scorecard was developed by combining site characteristics (rainfall, canopy cover, and slope) that affect animal use to quickly estimate grazing capacity. The scorecard approach can yield useful estimates of grazing capacity from a pasture or an entire landscape and is easily coupled to geographic information systems (GIS) to allow mapping of forage availability (Standiford et al. 1999).

For RDM management purposes, California grassland and associated oak woodlands and savannahs can be divided into three types. Recommended minimum RDM guidelines for each type are listed in scorecard form in tables 1 through 3.

- *Dry annual grassland.* Annual plant dominated (grasses, legumes, forbs), with average annual rainfall less than 12 inches (31 cm). Oak or shrub canopy is typically less than in other types.
- *Annual grasslands/hardwood rangeland.* Annual plant understory with variable oak or shrub canopy, average annual rainfall between 12 and 40 inches (31 to 102 cm).
- *Coastal prairie.* Perennial grasses common, variable woody overstory, annual rainfall variable but commonly greater than 35 inches (89 cm).

These guidelines provide livestock producers and other rangeland managers with useful information for managing rangeland. They were developed to help managers assess the proper level of herbaceous forage use, and for this reason they do not include measurements of other vegetation such as oak leaves and summer annuals. Included in the category of summer annuals would be such plants as yellow starthistle *(Centaurea solstitialis)*, turkey mullein *(Croton setigerus)*, and tarweed (*Hemizonia* and *Holocarpha* spp.). While these plants and plant parts do provide soil protection, they do not figure into current livestock management and so are not included in these guidelines. If the goal were to assess site protection regardless of the type of land use, RDM standards could be developed including oak leaves and summer annuals.

Table 1. Minimum RDM standards for dry annual grassland in pounds per acre (dry weight)

Woody cover	RDM standard for percent slope (lb/acre)			
(%)	0–10	10–20	20–40	>40
0–25	300	400	500	600
25–50	300	400	500	600
50–75	NA	NA	NA	NA
75–100	NA	NA	NA	NA

Note: Metric conversion: 1 lb/acre = 1.12 kg/ha.

Table 2. Minimum RDM standards for annual grassland/hardwood rangeland in pounds per acre (dry weight)

Woody cover	RDM standard for percent slope (lb/acre)			
(%)	0–10	10–20	20–40	>40
0–25	500	600	700	800
25–50	400	500	600	700
50–75	200	300	400	500
75–100	100	200	250	300

Note: Metric conversion: 1 lb/acre = 1.12 kg/ha.

Table 3. Minimum RDM standards for coastal prairie in pounds per acre (dry weight)

Woody cover	RDM standard for percent slope (lb/acre)			
(%)	0–10	10–20	20–40	>40
0–25	1,200	1,500	1,800	2,100
25–50	800	1,000	1,200	1,400
50–75	400	500	600	700
75–100	200	250	300	350

Note: Metric conversion: 1 lb/acre = 1.12 kg/ha.

ESTIMATING RESIDUAL DRY MATTER

A variety of means are available for estimating RDM. An easy and quick method is to visually compare photo standards (figs. 1–3) with conditions on the landscape prior to the first fall rains that result in germination, which normally occur around mid-October. Reference photos of grazing intensity standards have been developed for the Central Valley foothills using photos from the San Joaquin Experimental Range (SJER). A moderate level of grazing has been recommended for best livestock performance and rangeland protection for this region of California. Moderate grazing also provides more RDM than listed in the minimum guidelines described in tables 1 and 2. Other grazing intensities, described as light and heavy, are examples of too much or too little use. RDM levels corresponding to the photographed examples were collected for several years at SJER.

A primary means for measuring RDM is by clipping plots. The guidelines in this publication were developed based on research that involved clipping all standing dry matter in the early fall as close to ground level as possible without undue disturbance to the soil surface. Experience with clipping to the 0.5 inch (12 mm) standard, as commonly applied in areas populated primarily with annual grasslands, leaves behind approximately 25 percent of the total vegetation weight, leading to an inaccurate assessment.

A combination of clipping and visually estimating RDM is commonly used to reduce sampling costs. This may take the form of a structured process, such as the comparative yield method (Haydock and Shaw 1975), or it may be a less structured process whereby an evaluator first clips plots and gradually learns to estimate the RDM by eye. These estimates are commonly recorded on maps and are used to develop visual depictions of RDM across a pasture or landscape (Frost et al. 1988).

Measurement is conducted in the fall prior to the first significant rain. While the timing of fall germinating rain is a moving target, the amount of RDM at that time is the critical factor that ensures soil protection and a favorable microenvironment for the coming year's herbaceous plant community. If RDM is measured earlier, an adjustment must be made to correct for losses from natural breakdown that occurs due to insects, environmental factors, and so on. Without grazing during the dry summer and fall, research has demonstrated that RDM will average a decrease in weight of 7 percent per 30-day period from the time of peak standing crop of annual herbaceous species to occurrence of the germinating rain in the fall (Frost et al. 2005). This rate can be used to calculate backward from the desired RDM amount in October-November to an amount that must be present earlier in the summer. In this study, RDM disappearance at individual locations ranged from a high of 13 percent per 30-day period to a low of no disappearance over the dry summer period in any 1 year. In situations where conservative use and a higher RDM standard is appropriate or desired, rangeland managers could use the higher observed rate of RDM disappearance, 13 percent per 30-day period, to determine the amount to left at an earlier date.

CLIPPING A PLOT

The technique for clipping a plot for RDM measurement varies between agencies and individuals. The following procedure, recommended by the University of California, is the method that was used in the research on which the guidelines are based.

1. Place the quadrat (usually 1 square foot, or about 1,000 square centimeters) on the ground surface.
2. Remove from the area within the quadrat all summer annuals such as tarweed, yellow starthistle, and turkey mullein.
3. Remove tree leaves.
4. Clip the remaining plant material within the quadrat as close to the ground surface as you can without disturbing the soil.
5. Rapidly collect as much of the clipped plant material as is practical without inadvertently including bits of soil.
6. Weigh the dry plant material (1 gram per square foot = 96 pounds per acre). The plant material should be air dry in October or November unless there has been unusually early rain.

Figure 1. Light grazing results in high RDM levels.

Figure 2. Moderate grazing results in the recommended moderate level of RDM.

Figure 3. Heavy grazing results in low RDM levels.

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