Field Test of a New Australian Method of Rangeland Monitoring

Suzanne Mayne
Neil West

Abstract—Managers need more efficient means of monitoring changes on the lands they manage. Accordingly, a new Australian approach was field tested and compared to the Daubenmire method of assessing plant cover, litter, and bare soil. The study area was a 2 mile wide by 30.15 mile long strip, mostly covered by salt desert shrub ecosystem types, centered along the SE boundary of the Eagle Bombing Range in NW Utah. Paired T analyses were used to see what differences in condition could be detected between Bureau of Land Management and U.S. Air Force lands occupying the same ecological sites. Because of low statistical power of the test, no statistically significant differences were detected between ownerships. We did however, find some numerical differences illustrating the strengths and shortcomings of the two approaches. The Australian technique was less time consuming but not more readily repeated than the Daubenmire technique. The Australian technique focuses on the importance of protecting soils against erosion. The Daubenmire technique allows collection of data for addressing biodiversity and weed invasion issues. Either or both methods can be done on the same locations, thus, the managers' objectives and budgetary considerations should guide choices of method(s) employed.

Introduction

Monitoring, while necessary for adaptive natural resource management, can become expensive and tedious. The monitoring process on rangelands has traditionally involved estimates of plant abundances in quadrats by species. Complete and accurate enumeration of abundance-weighted species composition in samples from plant communities requires practitioners who know the flora. Familiarity with the flora requires training followed by experience. Universities are training fewer people with lower levels of competence in field botany than was the case in the past. Agencies and other employers are offering fewer opportunities for young professionals to gain further experience in learning to identify plants. We, thus, need to explore additional ways to monitor rangelands that do not require as much investment in time to learn plant species as the traditional approach has entailed.

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Suzanne Mayne is Range Management Specialist, Natural Resources Conservation Service, 2047 N. Buckboard Drive, #4, Cedar City, UT 84720. Neil West is Professor, Department of Rangeland Resources, Utah State University, Logan, UT 84322-5230.

Methods

During the summer of 1997, we gathered field data for comparing a new Australian method (Tongway and Ludwig 1997) with a traditional approach (Daubenmire 1959) long used to enumerate vegetation cover in the Intermountain Region. Our study area was in northwestern Utah, along the southeastern boundary of the North Unit ("Eagle Bombing Range") of the Utah Test and Training Range in Box Elder and Tooele Counties, Utah. For a two mile wide by 30.15 mile long transect along this boundary, we compared characteristics of vegetation and soil surfaces for ecological site polygons (Creque and others 1999) that straddled the fence line separating the land managed by the U.S. Air Force (AF) from that controlled by the Bureau of Land Management (BLM). The fence at this boundary had been constructed in 1968 and differing management pursued thereafter. Prior to 1968, livestock, mostly sheep, had grazed the land under both current ownerships. Since livestock had been fenced out of the AF property for nearly 30 years, we expected to find higher (later seral) conditions on the AF side of the fence because of the greater opportunity for the vegetation to recover from livestock grazing impacts there.

Before we could evenhandedly sample the vegetation and soil surfaces characteristics under the two ownerships, we had to delineate polygons of relative high internal environmental homogeneity that could be expected to have the same potentials for vegetation and responses to management. In other words, the first step was to delineate ecological sites (Creque and others 1999). We did this in the field with conventional orthophotos (1:24,000 scale) taken between 1972 and 1978 (depending on the particular quadrangles involved). Polygons delineating individual examples of ecological sites were drawn on acetate overlays and questionable boundaries checked on the ground. We didn't distinguish polygons that were less than 5 ha in total size (the minimum mapping unit). We also didn't distinguish potential lobes of polygons less than 100 m in width. In other words, if there were small but nearly symmetrical inclusions of another possible ecological site within the polygon, these were ignored in the delineation. The width criterion meant that differing environments along bottoms of drainages or ridgelines were also ignored. Since we needed adequate area on both sides of the fence for reasonable sampling, we had to identify those polygons representing a given ecological site (ES) that straddled the fence and provided at least 5 ha area on each side. Each potentially sampled piece of land also had to extend at least 200 m along the same general slope in order for the Australian method (requiring a 100 m transect) to be accommodated with some buffer left for any disturbance created by fence building, fence maintenance, and changes in animal behavior next to the fence. We found

23 such opportunities. Color-coded maps of the individual polygons, the ecological site represented, and of our plot locations can be found in Sharik (2000). These areas were linked to the Natural Resources Conservation Service (NRCS) soil survey (Trickler 1986) of the UTTR and later county soil surveys of the adjacent BLM land by the NRCS. This process led to the grouping of the 23 polygons meeting our criteria into 4 of the commonest ecological sites. Nine comparisons were made in the Desert Loam ES, five in the Desert Gravelly Loam ES, five in the Desert Flat ES, and four in the Alkali Flat ES. The sampled sites are all variants of the salt desert shrub ecosystem type (West 1983).

The next step was select points to sample within the AF and BLM portions of the large enough individual site polygons straddling the fence line. We examined the variation in photographic texture across the paired portions of the polygon on the orthophotos and chose a location where texture was both homogeneous and representative of the entire polygon. We then went to that location in the field. Both plot locations and polygon boundaries were entered into a geographic information system (Sharik 2000).

At each of the 46 transects (one per each side of the fence) a 100 m tape was laid out down the prevailing slope. Along these transects, two types of ground cover data were taken: by the traditional Daubenmire and the new Australian method.

The Daubenmire approach involved placement of twenty-five 20 x 50 cm micro-plots at random points along one side of the tape. Within the micro-plots, plant canopy cover estimates were made by species using the cover classes suggested by Daubenmire (1959).

Under the Australian method (Tongway and Ludwig 1997), line intercepts of basal cover of only the perennial plants were recorded. While Tongway and Ludwig (1997) recommend that these data be recorded by growth form category, we recorded live plant cover by species as well. Litter was not distinguished by what plant species it likely was derived from. This approach yields some other attributes besides basal cover. The amount of distance between patches of perennial plants is termed "fetch length." This is a proxy for bare ground ignoring any ephemeral plants. The number of patches intercepted was also recorded, as were the widths of plant bases that were intercepted.

In order to gain a sense of repeatability in applying the two methods, four pairs of transects (one representing each of the four ecological sites encountered) were read by both methods a second time the next day following the initial reading.

Statistical analysis of the data derived from the Australian method was by the paired T method (Subcommittee 1962). A T-test for the results derived from the Daubenmire method was not performed because these data were not spatially independent from those of the Australian method (the main focus of our investigation). Both types of data were recorded along the same transect lines. The power of these tests and sample numbers required to reach predefined statistical adequacies were calculated by the methods suggested in Chapter 11 and Appendix A of Elzinga and others (1998).

Range condition, derived only from the Daubenmire data, was scored by two methods. First, the Grazing Lands Technology Institute (1997) method was used with reference to the Utah Condition Guides (Natural Resources Conservation Service 1998). A second approach, based on degree of dominance by native plants, as suggested by Anderson (1991), was also employed. We also calculated the percent of the encountered flora that were considered invasive. For the listing of which species were considered weeds see Sharik (2000).

Results and Discussion

Using the traditional (Daubenmire) approach showed numerically higher average total cover by plants and less bare ground on the AF than BLM side of the fence (table 1). Shrub cover was slightly higher on the AF side, whereas canopy cover of perennial herbs was identical (table 1). Annual herb cover, bare soil, litter and soil cover by microphytes (lichens, mosses, and algae) was nearly the same on both sides of the fence (table 1).

Range conditions were apparently the same on both sides of the fence using the traditional NRCS method (table 1). The degree of invasion by exotics was slightly less on the AF side. Since the Index of Naturalness is 100 minus the percentage of invasion by exotics, the AF property sampled has a higher value for this property as well.

The new Australian method didn't yield total plant cover data. It focuses instead on the basal cover of perennials, whereas the traditional method assesses canopy cover by all plants present at the time of sampling. It should be pointed out that the leaves of most of the cool season herbs had already shattered when the data were taken in July and thus, had probably become greatly diminished from their earlier stature. Warm season herbs were still growing in July, however, and thus would have greater contributions to cover if measured later.

We intuitively expected the Australian method to be more repeatable than the traditional approach. This is because the Australian approach focuses on the intercepted basal cover of perennials. However, when there are numerous small-sized perennials, it proved difficult for the same intercepts to be encountered during the second reading. Thus, the eye adjustments required in the Daubenmire canopy cover method may compensate for the inexactitudes of line intercept approach. The Australian method presents data bearing on the fragmentation of perennial cover (Kuehl and others 2001), features not addressed by the traditional method. For instance, the mean fetch length was greater on the AF side of the fence (table 1). This means that there was more distance between clumps of individual perennial plants and their more durable litter there. In other words, more bare ground in larger patches occurred on the AF side. Mean patch width was greater on the BLM side (table 1). This suggests that perennial plants were, on average, larger there.

None of the differences discussed above were statistically significant at anywhere near conventional levels (table 1, fourth column). This was because statistical power was low (table 1, fifth column). In order to reach within 10 percent of the true mean with a 90 percent chance of not making a Type I error, we would have had to employ many more transects per polygon (table 1, sixth column). This would have greatly increased the cost of monitoring, especially for the traditional method. The Australian method is faster and focuses only on the perennial cover, thus statistical adequacy could

Table 1—Summary of overall results obtained by the two methods on the two sides of the fence. BLM = Bureau of Land Management, AF = Air Force, T = probability of a statistically significant difference with a chance of a type I error of one in ten. N = number of samples, that would have to have been obtained for a statistically significance (p = 0.10) to have been obtained.

	BLM	AF	Difference	T	Power	n
Daubenmire method (percent of ground covered)						
Shrub cover	14	16	2		0.135	370
Perennial herb cover	2	2	0		0.057	1,811
Annual herb cover	13	12	1		0.029	7,322
Microphytic crusts	43	42	1		0.028	47,550
Total plant cover	30	31	1		0.077	934
Litter	4	4	0		0.928	26
Bare ground	10	9	1		0.176	260
Total	112	113	1		0.026	80,091
Range condition	48	48	0		0.068	1,228
Degree of weed invasion	36	33	3			
Index of naturalness	64	67	3			
Australian method (per 100 m)						
Mean fetch length (cm)	580	910	321	0.309	0.156	304
Percentage in fetches	5.8	9.1	33			
Mean patch number	26	24	2	0.096	0.037	463
Mean total patch width (m)	4.3	3.4	0.9	0.612	0.116	463

be reached with fewer samples (table 1, sixth column). Another advantage of the Australian method is that it is based on a concept that allows scaling up to landscapes and provides means of connecting the data to estimates of soil erosion and nutrient conservation (Ludwig and others 2000).

Conclusions

Choice of methods to use in monitoring of rangelands should follow expression of what the land is being managed for, balanced against costs and reliability of the method employed. For instance, the Australian method assumes that protection of the soil against erosion is the number one land management issue. Tongway and Ludwig (1997) also assume that ephemeral vegetation and microphytes (mosses, lichens, algae) play no decisive role in protecting the soil. Contrary to what Tongway and Ludwig (1997) assert, choosing this focus on soil protection is not a value-free choice, but as much a moralistic decision as choice of any other condition objective.

The Australian method does not involve creating a full species list with any expression of their abundance for example, cover. Without practitioners trained to identify plant species, the best that can be done under the Australian approach is an enumeration of a modest set of life form categories for the perennials only. Thus, if differences in species level biodiversity within the entire plant community is something one desires to know, a more traditional approach must be employed. These kinds of data are required to calculate indices of similarity to reference states such as usually done by the Grazing Lands Technology Institute (1997) or using the Index of Naturalness (or degree of invasion that is its inverse) as suggested by Anderson (1991). Keeping these traditional approaches in play will require that universities keep introducing students to the topic of plant taxonomy and that employers give their new employees opportunities to improve upon those initial skills.

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