FORUM

AN APPRAISAL OF MONITORING STUDIES IN SOUTH ISLAND TUSSOCK GRASSLANDS, NEW ZEALAND

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The success of studies of change in South Island tussock grasslands can be assessed indirectly by the form in which their results are presented - scientific paper, institutional bulletin, popular publication, conference proceedings, unpublished report, or not at all. Studies often fall short of their potential to increase understanding of the effects of natural processes or management: the results of many simply never reach either the authority that commissioned them or the public in general. The application of some general principles to the definition of objectives and choice of methods could considerably enhance the success of such studies.

Keywords: monitoring; objectives; methods; tussock grassland.

Monitoring is defined for the purposes of this article as the periodic remeasurement of appropriate parameters by comparable methods at fixed sample locations to detect long-term vegetation change. Research involving vegetation monitoring has been carried out in South Island tussock grasslands by several agencies since the 1930s (McKendry and O'Connor, 1990). Information on monitoring methods has been collated as unpublished reports (e.g., Craig, 1989; McKendry and O'Connor, 1990; Meurk and Buxton, 1991), and indicates that several methods have been applied in the pursuit of a variety of objectives. However, there has been little critical appraisal of the success of monitoring, although methodological shortcomings have been discussed by some authors (e.g., Scott, Dick and Hunter, 1988).

A review of 56 completed vegetation monitoring studies in tussock grasslands, representing many hundreds of sites monitored by local authorities, scientific institutions, and land management agencies, showed a range of objectives, methods, and parameters measured. The records included a total of 62 combinations of objective and method. Several studies had more than one objective and/or used more than one method. Most (45%) studies were intended to monitor changes in vegetation resulting from management of grazing, including complete exclosure of animals, control of feral ruminant numbers, and changes in the grazing regime of sheep. A much lower proportion assessed the effects of fire (13%), soil conservation measures (10%), introduction/invasion/management of new plant species (15%), and general or unspecified environmental change (8%). The lowest proportions monitored population trends in rare plants (6%) and the effects of competition from introduced ruminants on food availability for native birds (3%).

Parameters measured or estimated were plant cover, frequency, abundance/dominance, biomass, density, nutrient levels, population size, and population structure, soil nutrient levels, and animal activity. Photographs (26% of studies; e.g., Whitehouse *et al.,* 1988) and quadrats (23%; e.g., Treskonova, 1991) were the sampling systems most frequently used to record change, followed by point/line intercepts (19%; e.g., Scott *et ai.,* 1988), plots arranged on transects (18%; e.g., Allen and Partridge, 1988), height-frequency (10%; e.g., Dickinson, Mark and Lee, 1992), and marked plants (5%; e.g., Payton and Mark, 1979).

An appraisal of the success of these studies can be based on the fate of their results. The method most frequently completely unreported was photographs (64% of the 14 studies using this method), followed by quadrats (46% of 13), height-frequency (40% of 5), marked plants (33% of 3) and intercept (33% of 12), and plot/transect (22% of 9). That most frequently reported in refereed

scientific journals was plot/transect (44%), followed by intercept (42%) then height-frequency (40%), photographs (36%), marked plants (33%) and quadrats (23%). Plot/transect (33%) and marked plants (33%) were the methods most frequently presented as unpublished reports. Three studies presented in institutional bulletins, conference proceedings or popular publications used intercept, and three used quadrats.

Change in tussock grasslands can be measured successfully by all of these methods. However, the usefulness and scientific acceptability of the results that can be obtained by different methods evidently vary widely, and do not always seem to have influenced the choice of method. This has resulted in a substantial waste of resources, and in important opportunities foregone for increasing understanding of the ecology and management of tussock grasslands.

In particular, the results of the majority of studies using photographic methods to record cover and frequency have not been formally presented, either to the institutions commissioning the studies or in a form accessible to, or able to be critically assessed by, scientists or the public. On the other hand, cover was reliably measured by variants of the line and point intercept methods, and provided data applicable to all objectives of monitoring apart from assessment of population trends of rare plants. Frequency was recorded in systematically or randomly distributed quadrats, or as height-frequency in vertically contiguous volumes. Its accuracy is limited by the recorder's ability to find and correctly identify either target plant species or all plant species present in a sample. It is applicable to all of the listed objectives of monitoring.

The use of density records appears to add little to the information gained from cover data, particularly in grassland where individual plants are difficult to distinguish for many species. The main usefulness of density records is in population studies where the permanent labelling of individual plants is not practicable.

Biomass estimates from height-frequency measurements appear particularly informative in studies of vegetation change in relation to management, for example, of grazing or fire, because they indicate vegetation structure as well as composition. Biomass estimation is applicable to all the objectives of monitoring except assessment of population trends in rare plant species.

Monitoring of marked plants has proved useful and acceptable for following changes in species' population size and structure and changes in plant nutrient levels, but has not been applied to the other objectives of monitoring. Abundance/dominance records appear too infrequently used to provide temporal or spatial comparisons of widespread applicability.

Uncertainty about objectives and appropriate methods of monitoring appeared to be a major constraint on the presentation of results of many of the studies. This uncertainty could have been resolved by the application of some general principles to the definition of objectives and the choice of both monitoring methods and parameters measured to record change in tussock grasslands.

The objective of monitoring must be clearly defined so that parameters which best describe the change to be monitored can be selected for measurement. The method used must provide an economical and accurate measurement of these parameters and thus of change. If the agent of change, for example, grazing, fire, rainfall, or fertiliser application, is clearly identified, potential sources of variability in the data obtained can be recognised and accounted for in interpretation of the results. It is also important to avoid collecting data that do not contribute to the objective of monitoring.

As a general rule, data should be collected in a way that allows comparison of results not only between years, but also between sites and between studies. Methods should reflect the likelihood of successive sets of data being recorded by the same person, or by people with the same ability, or at different seasons, and should also take account of the type of data collected at sites and in studies with which a comparison is desired.

This appraisal has shown that, unfortunately, many past studies have not realised their potential to increase understanding of the ecology and management of tussock grasslands. From these, it is evident there is no simple recipe for deciding on a method of vegetation monitoring to fit a particular set of circumstances. However, it is clear that careful definition of objectives and appropriate choice of methods would lead to results that are both more informative and more accessible.

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