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Monitoring

Western Australia's rangelands

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Rangelands, native pastures used for grazing domestic livestock, occupy about 100 million hectares or 40 per cent of Western Australia, extending from the tropical grasslands of the Kimberley to the arid shrub steppe of the Nullarbor Plain.

These areas support about 2.5 million sheep and 850,000 cattle, 8 and 49 per cent respectively of the State totals.

The rangelands are characterized by highly variable seasonal conditions. Carrying capacity can fluctuate dramatically from year to year. Grazing management requires a tactical approach from one season to the next because of the great variation in the capacity of the land to support stock. In such uncertain environments pastoralists must aim to maintain the palatable perennial pasture species which are essential for relatively stable animal production. Managers need to observe the effects of grazing on pastures and soil and vary stocking rates and stock distribution accordingly.

Rangeland monitoring provides pastoralists with objective information on these changes to assist their management decision making. The Western Australian Rangeland Monitoring System (WARMS) is being developed for this purpose.

Rangeland monitoring programmes can also provide land management agencies with information concerning long term changes in the State's land resources. This information will help foster a viable pastoral industry consistent with the wider objectives of conservation and sustainable land use.

Designing a monitoring system

Rangeland monitoring systems are generally based on the assumption that changes observed on carefully selected sites or "key areas" can be used to assess management effects over larger areas.

Effective monitoring systems should provide pastoralists with readily understandable data on changes in vegetation and soil conditions, and also some method of interpreting what caused these changes. These causes, and their relative importance, cannot be precisely identified, but they need to be assessed to determine whether observed changes are likely to involve grazing effects or are merely the result of seasonal variations. In addition, monitoring sites should provide useful information for management even when varied pasture types occur within the one paddock or management unit.

The latter requirement can most easily be met when monitoring sites are installed following the completion of regional rangeland surveys.
although this is not essential. Knowledge of the pasture types occurring within each paddock, and estimates of their potential carrying capacity, allows monitoring sites to be located in the areas which contribute most to potential pastoral productivity, and towards which management should generally be directed. Site selection combines such information with the accumulated experience of pastoralists to ensure that local anomalies in grazing distribution are avoided, and that areas of special management interest are identified.

Interpretations of the relative importance of grazing and seasonal or environmental factors in producing the changes observed at monitoring sites will always be difficult. However the establishment of sites in “reference areas” on each lease, where grazing pressure is known to be light because of distance from water or other factors, and in fenced “bench-marks” established on a regional basis, can provide comparisons from which informed judgements can be made.

Historical developments

The need to develop methods for rapidly collecting information on changes in perennial plant populations and soil conditions, over large areas, has long been recognized by rangeland advisers.

Large scale aerial photography

In the late 1960s the use of large scale aerial photography appeared to offer much promise for this purpose.

In 1970, the Western Australian Department of Agriculture, in conjunction with the Rangelands Research Unit of CSIRO, undertook the first Australian assessment of such photography for rangeland monitoring. This study indicated that large scale (1:200) colour or colour infra-red photographs were an ideal base for mapping and recording of individual plant species in a range of vegetation types. Acceptable estimates of plant cover could also be made and the condition of the soil surface was clearly recognizable, particularly on colour infra-red film.

However neither film type permitted highly accurate identification of all species examined. Furthermore, for best interpretation, photographs needed to be taken within four to six weeks of effective rain and some plants growing beneath tree canopies were obscured by foliage or shadow.

Nevertheless, the results of this investigation were generally encouraging. In the following years over 100 “flight lines” were established on pastoral leases, particularly where existing exclosures enabled nearby grazed and ungrazed areas to be photographed, and in paddocks in which other research programmes were in progress.

Large scale aerial photography has proved to be an excellent research tool in studies which require data on changes in plant populations or the spatial arrangement of plants. However, it soon became evident that the task of establishing permanently marked flight lines, the cost of acquiring and printing the photographs, and the labour requirements for “marking-up” in the field (since plant species could not be identified accurately from the photographs alone), would preclude the use of the technique for an extensive monitoring programme.

Development of alternative methods subsequently proceeded along two lines.

Photo points

Photographic records of permanently located sites, obtained with a hand-held camera from an elevated position such as the roof of a vehicle, proved to be a simple, rapid and cost-efficient procedure.

Several hundred of these “photo-points” were established, particularly in the East Gascoyne, Murchison and Goldfields areas, and standardized procedures for delineation of the “photo-plot” and recording of plant populations on photo-overlays were developed. The major limitation of this technique was the small area that could be included in the field of view, although the method did provide for general landscape photographs to be taken, in a standardized fashion, simultaneously with the “close up” plot photograph. Another limitation was the lack of any provision for adequately describing the condition of the soil surface.

“Plotless” sampling

The second line of approach involved attempts to measure plant density over larger sample areas, and to provide more definitive information on the condition of the soil surface. The “plotless” sampling method used to determine plant density proved unreliable in most situations and this approach was never implemented as a practical procedure. However, the definitions developed for the rating of soil surface condition in terms of the type, intensity and extent of accelerated soil erosion proved reasonably workable. Operators could at least rank the soil condition of a site, based on defined criteria.
The WARMS technique for arid shrublands

The WARMS technique now used in the shrublands south of Kimberley combines the most desirable features of the earlier approaches with additional soil and vegetation data.

Monitoring sites (Figure 1) usually consist of a photographed area or “photo-plot” to provide a permanent visual record of change, and a series of fixed “belt” transects within which shrubs are individually recorded in terms of species, and canopy width and height.

Species which cannot be readily measured because of their growth habit are counted. These data are recorded within subsections of the transects called blocks. This allows overall changes in the total population of a species, or group of species, to be understood in terms of gains and losses within individual blocks. The density of shrub seedlings, and of herbage and grass species, is scored on an interval scale. Plant counts within the photographed area supplement data from the larger area sampled by the transects.

Soil surface condition is assessed on quadrats located at regular intervals between the transects. The erosion status of the site overall is rated by using the scale and definitions discussed previously.

This method has been adopted as the standard procedure for monitoring sites in the shrublands, except in some degraded situations where low plant density does not justify the recording of detailed vegetation data. In these situations, soil condition is assessed in the usual way, but vegetation recording is restricted to the photo-site. The photographic record itself provides the most useful assessment of change in these circumstances.

The same procedure is used on “reference sites” located in areas of low grazing pressure. These sites, together with fenced bench-marks, will provide comparative data to assist with interpretation of the likely causes of the observed changes in the vegetation. At the bench-marks, more detailed and more frequent data, recorded both inside and outside the fenced area, will add to the understanding of vegetation changes in relation to both grazing and seasonal conditions. This information will assist with the development of management strategies designed to foster or ameliorate changes observed at monitoring sites.

Tony Crook of Woolabah Station checks changes in vegetation on a monitoring site against photographic records.

Figure 1. Layout of a typical WARMS monitoring site in the southern shrublands.
Field procedures
The site installation and data collection procedures of the WARMS system have been developed into a rapid and efficient technique.

After selecting the site location, the photo-plot and transects are permanently marked with galvanized pegs and steel pickets for ease of relocation at subsequent assessments.

Four main types of data are collected at each site.

Site description details. These are recorded on a standardized Site Information Sheet and include the site identification code, land system and pasture type, location description, aerial photo reference, map grid co-ordinates and recording specifications.

Photo-plot information. Plant counts within the photo-plot are recorded on a proforma which includes provision for coding and description of unknown species.

Three photographs are taken. These include a colour slide for long term storage, a colour print for enlargement and presentation in the station monitoring file, and a polaroid print on which plant species in the photo-plot are identified in the field for later transfer to an overlay on the enlarged print.

Soil surface condition information. The results of quadrat sampling for soil surface condition and the overall site erosion rating are recorded on the Site Information Sheet.

Vegetation transect information. All vegetation recordings on the transects are entered on a portable computer in coded form. These data are unloaded onto cassette tape in the field as each site is completed.

Data processing and report file presentation
Data from monitoring sites are summarized and returned to the pastoralist as a station monitoring file. The file is designed to allow pastoralists to observe their sites for any changes that may occur between assessments by Department of Agriculture staff. Observation of these changes (for example establishment of new plants or loss of part of the original population) allows management to respond at the earliest opportunity.

Data processing
When field work is completed all data are entered onto a computer at the Department's district office. These data are decoded, edited and summarized during preparation of the station monitoring file. The data are subsequently stored in a central data base so that comparisons can be made with previous or later recordings.

Monitoring file presentation
Site photographs are the focal point of the monitoring file because they help pastoralists regularly assess changes in plant populations. Each photograph is accompanied by an overlay prepared from the field polaroid which allows pastoralists to identify the important species present on each site. Summarized vegetation data from the transects are also presented, which indicate the population present at the start of the inventory programme, and changes observed since the last recording.

Implications for production of any changes noted on the sites are noted in the file, together with suggestions regarding the management options available for maintenance or improvement of the pasture resource.

These files are laminated and durable so they can withstand regular paddock use. When the completed file is returned to the pastoralist, rangeland advisers discuss observed changes in the rangeland and their implications with the pastoralist in relation to the management of the whole property.

Development of monitoring coverage
Rangeland monitoring has been enthusiastically embraced by many pastoralists; an indication of the growing trend towards conservative management systems in the rangelands. Installation of site networks has been particularly active in the West Gascoyne and Murchison where project teams supported by the National Soil Conservation Program (NSCP) have operated for the past five years.

Over 2,000 monitoring sites of various types have now been established in the rangelands. Progressive implementation of site networks, based primarily on requests from pastoralists, will see the coverage gradually extend throughout the pastoral areas. Eventually, the total network will probably exceed 10,000 sites.

The expansion of the monitoring programme has been made easier by the establishment of Land Conservation Districts. Eleven districts have been gazetted in the pastoral areas, and these, together with other districts being formed, will cover almost all of the rangelands.

The formation of Land Conservation Districts allows rangeland management to be tackled on a regional basis. Monitoring sites can be established as part of the development of large scale catchment management programmes which incorporate management plans for individual stations. Such a programme is
being undertaken in the Murchison River catchment, an area of about 60,000 sq. km, with support from the NSCP.

**Continuing developments**

Although monitoring site networks of the type described will provide useful information for both pastoralists and land administrators, the number of sites which can be established and maintained is limited by the staff available. At present, sites are being established at an average density of about one per 7,500 ha. A capacity to assess changes in the landscape overall would complement information collected from these sites. Work is proceeding on the evaluation of satellite (LANDSAT) imagery as a means of providing this overview.

Images from two dates, when processed to indicate the "brightness" or reflectance of the land surface, can be used to generate an image which depicts the pattern of change in landscape brightness between the two times of observation. These changes are influenced by grazing and seasonal conditions and particular patterns of change are represented by specific colours.

When such images are interpreted in conjunction with local knowledge of paddock stocking histories, seasonal conditions and trends in vegetation and soil conditions observed at monitoring sites, a much more complete picture can be built up. Such interpretations are made easier by the ability to overlay, using computer graphics techniques, the location of monitoring sites, fence lines, watering points and vegetation types on the processed LANDSAT imagery.

Pastoralists and advisers interpreting these combined images will be able to extrapolate trends from monitoring sites to larger areas with greater confidence, or alternatively detect areas where changes appear but where monitoring sites are not located. These areas can then be assessed in the field and additional sites installed if necessary.

To produce such combined images, large amounts of map data in digital or computer compatible form are required. All 1:250,000 scale maps of rangeland resources produced by the Department of Agriculture's rangeland survey programme have now been digitized and complete coverage will be built up as further surveys are completed.

Pastoral lease boundaries and property development details (for example fence lines and water points) are being digitized for all leases in the State in on-going programmes conducted by the Departments of Land Administration and Agriculture. Cost may prevent the routine production of these images but at least the capacity to produce them when needed is available.

Although monitoring procedures are well established in the shrublands south of Kimberley, techniques are still being developed for the northern grasslands. In response to a request from the pastoral industry and with the support of Cattle Industry Compensation Act funds, the Department of Agriculture has investigated a range of potential methods at Gogo Station. It was expected that the grasslands, with their denser plant populations, frequent fires and rapid growth responses to annual rain, would require different methods to the shrublands further south.
LANDSAT IMAGES

Two examples of the patterns of change in the "brightness" or reflectance of the landscape on a Nullarbor pastoral lease. The top image has been produced from LANDSAT data acquired in September 1982 and September 1985 while the other was produced from data acquired in September 1982 and September 1986.

In both cases the red tones indicate areas where landscape brightness was low in 1982 but increased up to the time of the second observation. Green tones indicate little change in landscape brightness.

The red areas are associated with grazing activity in the vicinity of sheep watering points, leading to an increase in brightness probably associated with changes in soil surface characteristics. The expansion in the area affected between 1985 and 1986 is evident from a comparison of the two images.

Red tones do not necessarily indicate overgrazing as evidenced by the red tones also visible along fence line tracks. However such imagery, when interpreted in conjunction with changes observed at ground sites, can help define the likely extent of changes measured on the ground, or identify areas where atypical changes should be inspected in the field.

As with the southern methods a network of ground-sites will be established, one or two in each management unit (paddock or water point vicinity). These sites will be readily accessible to pastoralists and will need to be visited regularly if they are to provide the most benefit to management.

Methods that show promise for these sites include oblique photographs of fixed areas (a feature included in the shrubland method) and plant mapping within permanently marked areas using photographs obtained by a vertically suspended camera. Estimation of the amount and species composition of forage available at a site in terms of biomass has proved difficult and the detection of grazing effects using this approach may be unreliable, especially given the staff changes to be expected in a long term monitoring programme.

An alternative being investigated is to group sites into a number of classes based on total basal cover (assessed relative to the potential of the site rather than in absolute terms) and the proportion of desirable species present.

Sufficient results will be available to allow the development of an operational method by late 1990 so that existing sites can be upgraded to provide a reliable monitoring service for the Kimberley pastoral industry. The frequency with which sites are recorded will need to be greater than for southern areas as changes in these grasslands can be rapid and dramatic.

Overall benefits

Pastoralists, land administrators and rangeland management advisers all benefit from the collection and analysis of information on changes in range condition.

The Western Australian rangeland monitoring system has been designed primarily to provide information which can assist pastoralists with practical grazing management decisions. In the medium term this information will be derived from data collected by Department of Agriculture advisers, but more frequent observation of sites by pastoralists themselves will provide the most important information for short term decision-making.

Data collected by the monitoring programme will improve advisers' understanding of the processes of change in rangeland environments thus enhancing their ability to recommend appropriate management responses. At the same time data on changes in range condition can assist with the decision-making of land administrators. It can provide the community with objective evidence that pastoral land use need not be incompatible with broader conservation objectives in the rangelands.