

## 2. Plenary presentations

- 2.1 Why monitor grazing lands?
- 2.2 What attributes to monitor
- 2.3 How to monitor vegetation and soils
- 2.4 Monitoring for resource management



*Our grazing lands are being monitored at varying levels by government environmental and research institutions. However, only when the managers on the land monitor the condition of their own pastures will grazing management become truly interactive. Here graziers in north Queensland learn the techniques for monitoring their own pastures.*

## 2.1 Why monitor grazing lands?

**Joe Scanlan**  
**Land Protection,**  
**Department of Natural Resources, Queensland**

### Abstract

There is much interest in monitoring grazing lands in Australia, and several research methodologies have been developed and extensively tested. Most states have implemented monitoring programs to assess pasture condition and woody plant populations, but these do not cover all agricultural land uses, and the methodologies and rationales vary considerably between the states. Relatively few landholders currently use a formal system of monitoring resource condition on their properties.

The information obtained from monitoring systems must be closely linked to the management imposed on an area if monitoring is to have a meaningful role on individual properties. If linkages to management are not forged and if resource monitoring is not undertaken, rural industries will become more open to criticism and may rule themselves out of production and marketing opportunities.

### Introduction

One simple answer to the question of 'Why monitor agricultural properties?' is 'To promote sustainable agriculture and rural development'. While monitoring alone will not achieve this, it is an essential component of a complete management strategy. There is a great deal of emphasis on property management planning as a means of achieving technological change; however, without monitoring the implementation of such change, there is no means of evaluating its effectiveness.

This paper provides a general background to monitoring as part of land management, discusses what constitutes monitoring and what are the outcomes expected from monitoring schemes. It also considers the limitations or constraints to implementation from the perspective of both the industry and individual land manager. It is not intended as a review of monitoring systems developed for Australia's grazing lands.

### Background

#### The need for monitoring

Concerns about land degradation have been expressed throughout the rangelands of the world. In northern Australia, the combination of economic

depression, pests and diseases, and prolonged drought (Gramshaw and Lloyd 1993) led to severe land degradation by 1902. The most recent example of concern about the condition of Australia's rangelands is the Draft National Rangeland Strategy (National Rangeland Management Working Group 1996). Similar interest and concern are evident in other parts of the world, for example in South Africa (du Toit *et al.* 1991) and in the United States of America (Committee on Rangeland Classification 1994).

The first comprehensive book on management of Australia's rangelands had a chapter on *Range Inventory and Monitoring* (Harrington *et al.* 1984). In Queensland, many workshops have been held (e.g. Department of Primary Industries in 1977, 1995, 1996; CSIRO in 1993 and 1994), and state agencies established permanent transects to follow woody plant dynamics (e.g. two major sites in mulga lands of western Queensland - Burrows *et al.* 1985; 40 sites in central Queensland grazed eucalypt woodlands - E.R. Anderson pers. comm.; transects in exotic woody weeds infestations - M.P. Bolton pers. comm.). In 1992 and 1996, there were plenary sessions devoted to monitoring at the Australian Rangeland Conference. A similar list of activities could be prepared for other Australian states where rangelands form a significant proportion of the land area.

Many reports, reviews and strategies describe the need for monitoring and its application.

*There is general agreement that Australia would be in a stronger position in relation to sustainable farming if there were more information to guide timely assessment of trends in the resource base, to predict what this means in terms of future incomes, to indicate where and when adjustments in farming practices are required and to indicate how such things may be encouraged or brought about (ACIL 1994).*

*Seldom in the short history of rangeland management has the condition of the rangelands ..... received so much attention. One of the stated objectives of the sweeping changes in grazing regulations in Rangeland Reform was to "accelerate restoration and improvement of public rangelands although no consistent criteria were*

*provided for deciding whether such improvement had occurred" (SRM 1995).*

*Although objective monitoring of range trend is underway in most states in Australia, there has been inadequate attention paid to the interpretation and application of this information to management (Burnside and Faithful 1993).*

*Monitoring is essential to evaluate successes or failures of any management strategy adopted. It also provides an objective means of adapting such strategies should they fail. (Aucamps et al. 1992).*

*There is widespread deterioration in most pasture communities in Queensland; this is indicated by undesirable changes in pasture composition and soil surface characteristics such as cover and organic matter content (Tothill and Gillies 1992).*

Among the strategies for maintaining sustainable condition outlined by Tothill and Gillies (1992) were:

**Resource monitoring:**

- to help understand processes leading to sustainability or degradation
- to aid in management
- part of on-going leasehold monitoring.

**Education:**

- to develop participatory learning
- to help develop appropriate decision support systems for managers

**Review of leasehold sizes and covenants**

These strategies have a strong relationship with monitoring or rely on the output of any monitoring schemes. Given that the above study was commissioned by the leading producer-funded research organisation for the beef industry (Meat Research Corporation), these strategies and conclusions are relevant to government and its policy on leasehold land.

**Monitoring schemes**

Those states and territories with rangelands have established monitoring systems for those lands. In Queensland, these include systems for monitoring mulga lands (MAP, C. Evenson *pers. comm.*); sites for scientific study across all major pasture systems (QGRAZE, E. R. Anderson *pers. comm.*); and sites for individual landholder usage (GRASSCHECK, Forge 1994). In the Northern Territory, the Centralian Range Assessment Program (Bastin 1989) was established for research staff to assess range condition and trend and as the basis for providing advice to pastoralists and government. The Northern Territory Department of Lands, Housing and Local Government (1994) have a program to survey pastoral leases with the work being done in close collaboration with the lessee. Western Australia has a rangeland monitoring system designed for grazier use (Western Australia Department of Agriculture

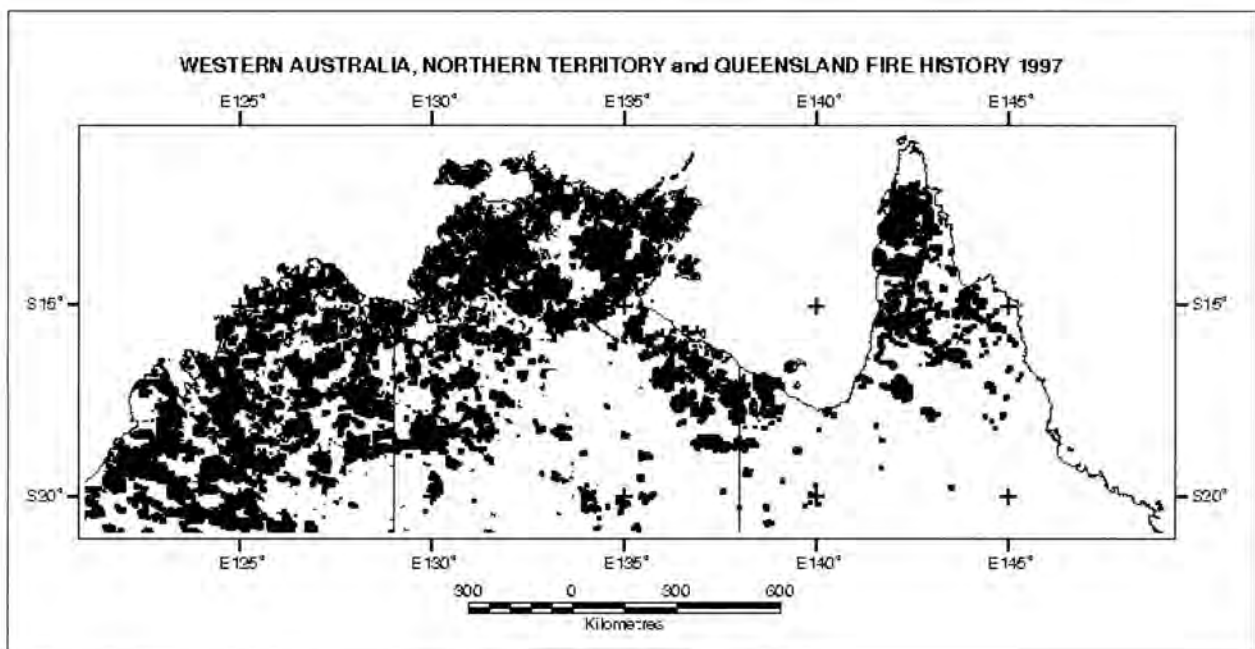


Plate 2.1.1. Levels of monitoring – satellite imagery. Fire scars mapped during the 1997 fire season using imagery from the NOAA-14 satellite. (Produced by Satellite Remote Sensing Service, Department of Land Administration, WA)

1992; Hunt and Gilkes 1992). New South Wales has had information for graziers on pasture assessment for some time (Soil Conservation Service 1987). Under South Australia legislation (Pastoral Land Management and Conservation Act 1990), monitoring of pastoral leases must be undertaken to assess their condition (e.g. Lay and McDonald 1996).

As a result of these monitoring schemes, there is widespread recognition of the need for monitoring by both government and private land managers. However, there appears to be relatively few coordinated monitoring schemes in which landholders participate in all phases of the monitoring—from site selection to data collection to interpretation and finally into altered management practices. Monitoring must be accompanied by the commitment to change management on the basis of the monitoring results and, to effect change, the land manager must be involved.

## What is monitoring?

A number of different activities fall into the category of monitoring (from Hellowell [1995]):

**Surveys.** Surveys are exercises in which a set of qualitative or quantitative observations are made, usually by means of a standardised procedure and within a restricted period of time, but without any preconceptions of what the findings ought to be.

**Surveillance.** An extended program of surveys undertaken to provide a time series to ascertain the variability and/or range of states/values which might be encountered over time. Again there are no preconceptions of what the values should be.

**Monitoring.** Intermittent surveillance carried out to ascertain the extent of agreement with a predetermined standard or the degree of variation from an expected norm.

Under these definitions, much of the *monitoring* in rangelands is *surveillance*. The aim, however, should be to move toward true monitoring, where measurements were taken in relation to some predetermined targets and if the variation from those targets is too wide, management action has to be taken. The targets that are set may be those of the land manager or they may be specified in regulations or licence conditions.

There are many similarities between 'monitoring' and formal experimentation.

There are several key steps that must be followed to gain most benefit from any monitoring program.

These are:

- set objectives
- plan to meet objectives
- undertake data collection
- analyse data
- draw conclusions and implement changed management

My impression is that the third aspect is done well by those who undertake monitoring, but that the first and last steps are often lacking completely or at least not adequately considered or documented. Unless all elements are put in place, the full benefits of monitoring will not be achieved and the resources used in the monitoring would have been wasted.

## Outcomes of a monitoring program

Better management and protection of our natural resources are the goals of responsible land managers. The justification for implementing a monitoring program falls into one of three general categories.

**Assessment of the effectiveness of policy or legislation**

In the future, the community will expect rangelands to be well managed and to be assured they are, even though they do not necessarily want to live there or to visit these lands. The effectiveness of any government or community programs put in place to manage areas will have to be assessed, and monitoring could play an important role in this assessment.

**Measurement of some aspect in relation to a specified target**

Landholders are becoming increasingly interested in quality assurance e.g. the 'clean-green' image; the disease-free status of herds. This requires measurement throughout the production cycle i.e. monitoring. Monitoring of production has the associated benefit of assisting in technology transfer. There is much concern, discussion and debate about the most appropriate approach to technology transfer, but a common element is action learning. Monitoring can be an important element of such approaches.

**Detection of incipient change (early warning systems)**

One of the challenges is to detect and deal with long-term change amid a background of the extreme variability that characterises many parts of the Australian environment. Variation can be random, successional or cyclical; it is essential to understand

which is applicable in order to interpret the changes that are observed and to respond to them. The more severe the impacts or the more likely that changes are irreversible, the more important these early warning systems are. Burnside and Faithful (1993) point out the difficulties faced in interpreting change.

Detection of change provides an objective basis for changes to management. Detection of change alone is interesting but not valuable until it can support new or modified management practices. Assessing recovery or change after management has been altered is another key aspect of monitoring systems.

### Purpose of monitoring

There are many specific aspects of resource management with which monitoring can assist.

**Detecting long-term change.** Climate change has the potential to alter many aspects of land management, through impact on rainfall amount, intensity and distribution, through direct effects of temperature on plant and animal distribution, possible effects of enhanced CO<sub>2</sub> on lowering forage quality and possible effects of CO<sub>2</sub> on changing the balance between C<sub>3</sub> and C<sub>4</sub> species (particularly trees

versus grasses). These changes will be subtle and will be totally obscured by normal climate variability unless sophisticated monitoring systems are in place.

Monitoring may be a tool for supporting research activities, and is especially useful for long-term changes where different researchers may have to be involved over time. The rigour that a monitoring program imposes makes it more likely that continuity is achieved and that results are reliable and interpretable.

**Determining the impact of new organisms.** Disease spread is a recognised and accepted issue in which monitoring plays a key role.

When new weeds are located, 'search and destroy missions' are put in place. These have been generally effective in containing the problem, with a recent example being Siam weed (*Chromolaena odorata*). When exotic weeds have reached their ecological range, little effort is expended on monitoring (at government level) as few insights can be gained once baseline population flux is understood. At intermediate levels, monitoring by landholders and governments is important for on-property management and for policy formulation.

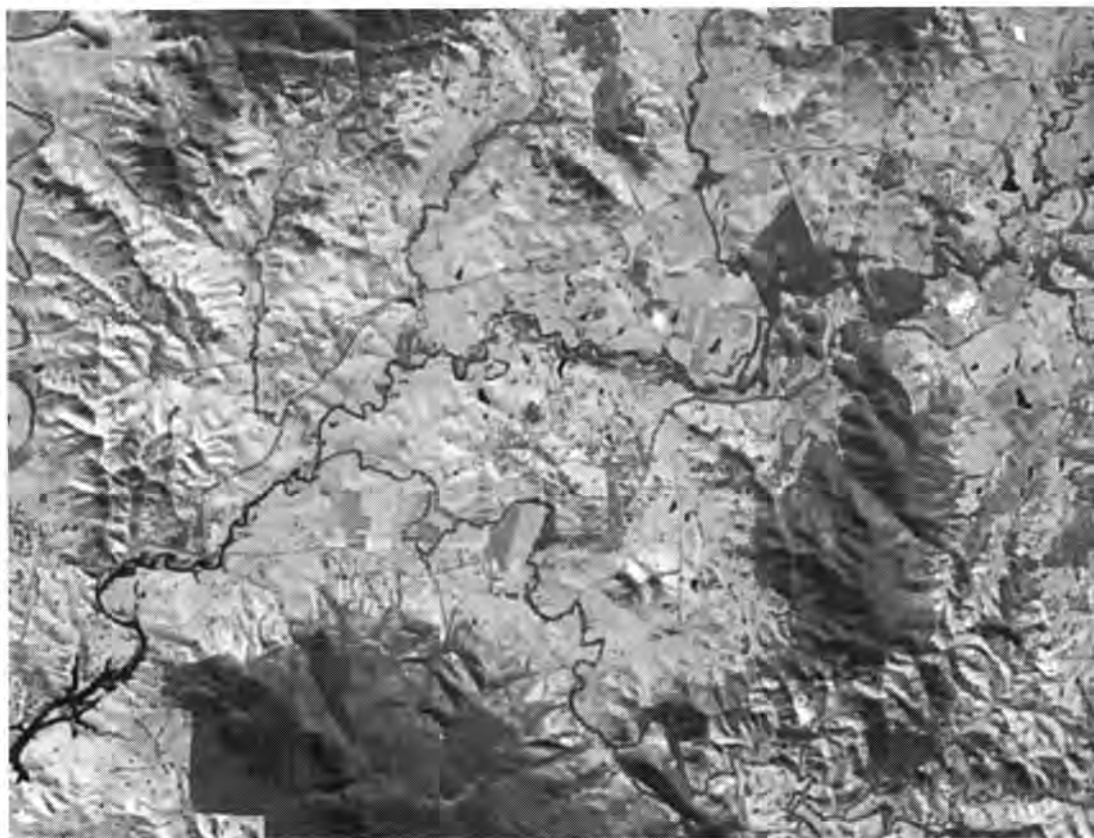


Plate 2.1.2. Levels of monitoring – satellite imagery. Land use monitoring from passes of Landsat TM satellite.

The spread of the rabbit calicivirus has highlighted the desirability of having good baseline data over extensive areas and over an extended period. In the absence of such data, the impact of the disease will be difficult to establish unequivocally. Rubbervine rust is a similar case. A formal experiment or a formal monitoring strategy might not be needed when the impacts are dramatic and apparent without monitoring.

**Planning.** Much emphasis is being placed on property management planning. However, planning should be coupled with monitoring to assess the impact of new management strategies; the impact can be determined from baseline information before implementation and changes during and after implementation.

The degree of effort expended in monitoring should be related to the importance of results. With unlimited resources, all aspects of the natural environment could be monitored, but public resources for such activities are declining. Despite this, the general public is seeking more accountability and more assurance that our natural resources are being well managed. Many of the questions being asked about condition and trend of natural resources would be much easier to answer if extensive monitoring systems had been in place. However, it is difficult to anticipate the future value and use of data and so few comprehensive systems have been established. Funding tends to be either inadequate or short-term only.

**Forecasting events.** Plague pest monitoring is a case where monitoring forms part of strategic planning and control programs. The 1995 mouse plague in Queensland was anticipated, and contingency plans were put in place before the actual plague started. Although the magnitude of the plague was not predicted, the prior warning was attributed to the success of the control campaign.

**Changing management.** Many graziers tend to manage their livestock rather than their land and vegetation resources. However, stock condition can be maintained even though pasture condition has deteriorated significantly. To change this, workable and repeatable means are needed by which these managers can assess change in the resource base. Systems are available for graziers, but their uptake has been slower than anticipated or hoped.

The links between resource condition and economic sustainability need to be better understood if changes in management are to be based on objective assessment of resource condition.

**Determining effectiveness of management change.**

Relevant questions that a landholder may ask about the impact of change include: 'How am I doing now compared with how I used to be?'; 'How am I doing compared with others?'; 'If I do not change, what will happen?'; 'If I do change, how will I know whether anything is different?'. All of these questions require baseline data and on-going measurement against that baseline.

**Information exchange.** Monitoring sites can be a good way of transferring information to land managers as well as to policy makers, land administrators and researchers. This is especially so where new technologies are evaluated or where the impact of subtle changes in the resource base would go unnoticed without close examination of the same location over time.

Most people have seen how valuable paired photographs are for getting a message across, but all too often these are not supported by back-up information to assist interpreting the photographs. External factors can often completely alter any conclusions drawn. For example, an increase in woody plant density around a homestead may not represent a general increase if the original photographs were taken soon after original trees were cut down for firewood or for construction.

**Regulation.** In Australia's rangelands, only about 17% of the land area is held in freehold title (National Rangeland Management Working Group 1996). Land management on the remaining area is controlled to some degree by local, state or federal governments. Under the Queensland Land Act 1994, lessees have a general duty of care as well as specific obligations with respect to lease conditions. A good understanding of the condition of the land and how that condition is changing is needed to make appropriate decisions about how leasehold lands should be managed (either by government or lessees).

Conditions placed on the use of land should be such that irreversible change is precluded. The general duty of care required of lessees is an example of the general move from direct government involvement in prescribing management practices towards increased reliance on codes of practice and environmental audits. It will put greater responsibility on landholders to demonstrate they have been managing appropriately; For example, if a landholder follows the Code of Practice for Agriculture (a document prepared under the Environmental Protection Act), this will form part of legal defence should environmental damage occur. If the code is not

followed, the onus is on the landholder to demonstrate that the practices undertaken were at least equivalent to those contained in the Code of Practice.

The focus of governments is changing from prescription in terms of what should be done (e.g. setting maximum and/or minimum stock numbers per property) to what the outcome should be (e.g. maintenance of adequate ground cover to prevent erosion). There is a parallel need for processes to ensure that outcomes are measurable and achieved, i.e. monitoring systems are necessary.

The consequences of management carried out under some form of permit or licence must be monitored to ensure compliance with conditions placed on the permit or licence. A lack of monitoring reduces the power of licence conditions to ensure appropriate management outcomes.

### Who is monitoring grazing land?

Both public and private sectors have important roles in monitoring. As a generalisation, the public sector has the primary role in issues of a regional extent and of a long-term ecological nature, for example, the level and salinity of regional watertables. The

private sector has a greater role in matters relevant to individual properties and that are more directly related to production; an example of this may be pasture productivity and composition and its relationship to herd performance. Both sectors have an interest in the results of any assessments done by the other, for example the MRC-sponsored report on the pasture lands of northern Australia (Tothill and Gillies 1992) was extensively used in the State of the Environment Report for Australia (State of the Environment Advisory Council 1996).

A detailed listing of the roles of different sectors at different scales is presented in Table 2.1. While this may not be an exhaustive listing of what is monitored by whom, it indicates the importance of setting objectives and using methodologies which are appropriate to the scale being examined and to the user of that information. Some of the issues of scale, and of conservation *v.* production sustainability, are discussed by Morton *et al.* (1995). A key implication of scale differences is that no one monitoring system will provide all the information needed by all users.

The research community also has a role to develop and critique methodologies that may have a place in monitoring. Remote sensing has been pro-



Plate 2.1.3. Levels of monitoring – ‘Tier 2’ monitoring a Mitchell grass pasture in the Northern Territory.

Table 2.1. Who monitors and what is recorded at various scales of monitoring.

Scale	Who monitors?	What is monitored?
Site	Landholder Researcher Local govt. State govt.	Plant: <i>basal area, age, components</i> Soil: <i>surface condition, erosion rate</i> Water: <i>run-off</i>
Paddock	Landholder Researcher	Plant: <i>production, composition</i> Stock: <i>production per animal</i> economics: <i>value of production, partial budget</i>
Property	Landholder Researcher State govt. Federal govt.	Plant: <i>cover, composition, weed incidence</i> Soil/water: <i>run-off-erosion at sub-catchment scale</i> Stock: <i>herd performance</i> Economics: <i>farm business performance</i>
Region	Industry organisations State govt. Federal govt.	Plant: <i>weed distribution, pasture condition</i> soil/water: <i>catchment run-off, sediment concentration, regional water-table depth and quality</i> Stock: <i>regional production</i> Economics: <i>regional viability</i>
State	State govt. Federal govt.	Similar physical measures as regions Performance of research, development, extension or implementation programs Data for State of Environment (and similar) reports

moted widely for resource assessment (e.g. Tueller 1989; Johnston and Barson 1990; Werth and Work 1992; Tappan *et al.* 1992) and the steps in developing a remote sensing system have been outlined by Tueller (1991). Some of the key concepts for monitoring in Australian rangelands have been documented by Friedel (1990) and the difficulties associated with subjectivity in monitoring have been discussed by Stuart-Hill and Hobson (1991).

### Benefits to governments

There are both planning and regulatory aspects to monitoring at a state level. For planning, the history of a resource and its current condition must be known before a decision can be made as to what should be done in the future. From a regulatory point of view, there is a need to know what compliance there is (e.g. with licence conditions) and whether specific outcomes are being attained. Determining how people are responding to regulations indicates where any extra effort should be placed—whether it should be on education, assistance or enforcement.

### Benefits to community

Data from monitoring programs may enable policy decisions to be supported or opposed. The recent tree-clearing debate in Queensland has emphasised the difficulties that can arise when good data—on woody plant populations and the rate of clearing—were inadequate to make a completely objective assessment. Good data from permanent monitoring

sites would have made the debate much more rational and informed.

The other major benefit from monitoring programs is that the community can be confident that the outcomes they expect are being achieved.

### Benefits to individuals

**Researchers.** Researchers have always recognised the advantages of going back to the same site and measuring the same things year after year. While often tedious, this method provided very good data, e.g. on population changes for woody species and compositional changes for pastures.

Monitoring can detect subtle changes that may go unnoticed in simple surveys by taking out 'background noise' or natural variability in data.

**Landholders.** The benefits of monitoring must be clear to landholders before they will spend time and money on a monitoring program. A common reason for monitoring is to provide an accurate record of conditions over time—one not tainted by imperfect memories. Some pastoral companies have set up pasture monitoring programs, at least in part to overcome the problems associated with turn-over of managers on their properties.

To be of benefit to landholders, a system must be simple, repeatable and interpretable, and must enable the manager to determine if changes to management are needed. If change is desirable, monitoring can track the impact of that altered management.

Among the direct benefits of a monitoring program to a landholder are:

- documenting the actual level of production and the level of inputs to achieve that production
- helping to interpret the causes of variable production
- assessing the success of new management practices
- meeting requirement of a quality assurance program or government regulation
- assisting in marketing of product
- improving the 'saleability' of a property by having good records and showing the current condition in relation to previous conditions.

## Constraints to monitoring

Constraints to monitoring in northern Australia can be classified as:

### Government

**Cost** is a major factor for government, particularly in a time of general budget tightness. The direct one-on-one approach is becoming more the exception than the rule; the onus is on landholders rather than government agencies for data recording and assessment.

**Appropriate scale** of data collection. No one scale will give answers to all questions that may be asked. An assessment of 500 contaminated sites may be useful for some purposes; an assessment of 500 pasture condition sites across the state will have limited benefit for reporting on the state of the grazing resource, unless backed by a substantial amount of other data on relative distribution of certain categories of condition classes.

**Privacy.** The issue of individual privacy versus the 'rights' of the general community is relevant. Many individuals will accept information on their situation being pooled to give a district average, but are unwilling to have individual property information distributed.

### Landholders

**Immediate relevance.** Probably the greatest reason for landholders not monitoring is the perception that the information gained does not directly help with management decisions. Management decisions may be tactical or strategic; one monitoring system (particularly measurement of one attribute) will not be sufficient for both aspects, e.g. pasture yield may be useful for setting grazing pressure within a season

but the proportion of productive, palatable, perennial grasses may be a better indicator for adjusting whole-property stocking rates over the long term.

**Unclear linkages.** The link between resource condition and economic sustainability is not well understood. This is partly due to the long time for changes in resource condition to become evident, while the inherent variability in financial returns and resource condition of rangelands tends to obscure long-term directional change.

**Experience.** Some managers feel that they do not need a monitoring program as they have long experience on that property. This ignores the objectivity introduced by recording information compared with the subjectivity of memory

**Cost.** The cost of obtaining the information may be judged to be greater than the benefits to be obtained from having and using the data.

If a particular problem is more extensive than the individual property, there may appear to be little benefit from monitoring at the property level.

**Technical expertise.** A lack of technical expertise to measure certain parameters is sometimes proposed as a reason for lack of landholder monitoring.

**Complexity.** Some monitoring techniques are too complex, both for measurement and interpretation. However, since relatively simple techniques are still not being widely implemented, complexity alone is not the only factor.

**Whose responsibility?** Graziers sometimes feel that the government should bear the responsibility for assessing the condition of the grazing resource, particularly on leasehold land.

The systematic recording of indicators of sustainability must be put in place to improve the awareness of land degradation problems (ACIL 1994). Landholders must be convinced that there is a problem before they will spend extra effort and resources on management. Without some monitoring, problems have to reach extreme levels before there is common acceptance that management must change—by which time, management alone often cannot reverse the problems.

Although land managers are becoming more aware of land degradation, this does not necessarily translate into changed behaviour (ACIL 1994). Thus monitoring must be integrated with awareness of solutions to problems and with support and incentives for change towards sustainable management practices.

Once awareness of a problem becomes common, all available effort tends to be focused on remedying it. It may then not be seen as the problem of the individual to monitor its scale and intensity or the impact of remedial measures.

## Researcher

**'Real research'**. Many research organisations and funding agencies argue that monitoring is not real research as it may not be able to answer many fundamental questions. However, information from monitoring can be an integral component of the support for particular scientific arguments, e.g. permanent transects in woodlands provide evidence in the greenhouse gas and carbon sequestration debate, and monitoring is essential to validate simulation models.

**'All my own'**. Researchers are often reluctant to continue the work someone else has started, unless the project is long-term.

**Duration**. Monitoring requires a long-term commitment, but most funding is short-term.

**Outcome-oriented**. Most researchers are under pressure to deliver outcomes that can be assessed. Much monitoring falls within the realm of information gathering and increasing understanding, rather than delivering specific outcomes. Thus, researchers may not wish to start a program that does not directly benefit them professionally.

## Future prospects for monitoring

Monitoring will play an increasingly important role in society in general and in rural industry in particular. Some of the reasons for this are:

**Future land-use options**. The community expects that land managed for production should also maintain other values and future options. Within this general expectation, there will be a wide range of specific objectives that differ between sections of the community and differ between highly developed regions and undeveloped or wilderness areas. All these viewpoints and expectations are relevant to general land management issues and decision making.

**Product quality**. The public wish to be reassured that production methods are sustainable and that product quality is high. For example, products should be from properties that are using 'best management' practices and considering animal welfare issues, while being free of pesticide residues.

**Duty of care**. Landholders have a legal duty of care responsibility and are open to prosecution if not fulfilling that obligation (at least in some states).

**Freedom of information**. Land information is becoming easier to access. The wider community will be able to access information and detect changes, thus opening land management to greater scrutiny.

**Environmental pests**. Pest plants and animals have had a high profile recently, and several species have been the subject of major control programs. The effectiveness of the bio-control and integrated programs should be demonstrated by permanent monitoring sites set up prior to release of bio-agents and before large-scale control programs.

## Conclusions

All sectors of the community can benefit from monitoring at a range of scales. Monitoring linked with decision making and changed management is important from both economic and ecological aspects. The benefits must be measured against the resources required to undertake monitoring, and monitoring for its own sake should be resisted. Although there is a concern about ill-planned monitoring, a greater concern is that monitoring that should be done will not be done.

Both landholders and government agencies have a role in implementing and enhancing monitoring systems as one means of meeting the challenge of sustainable agricultural production.

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