1. Farming for a thousand years

Perceptions and expectations of monitoring

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Abstract

The past and present role of monitoring is examined. The conclusion is that:

- Monitoring will be an essential feature of future agricultural management and resource use, a critical element for landscape managers in ensuring any utilisation is profitable and sustainable.
- Monitoring must be considered as a tool, not an end it itself. It should be simple to use, relevant to the capability of the user, and specifically designed to produce data for the strategic needs of management or research.
- Monitoring systems that do not meet these criteria are likely to fail.
- Monitoring systems have been designed and operated in a range of scientific paradigms and in varying academic and philosophical environments, and, like all sciences, cannot avoid being a product of the contemporary cultural milieu.

Because of this, the temptation must be resisted to assume that the existence or emplacement of a monitoring system, a simple tool in the process, will resolve arguments over resource use or prevailing and competing ecological paradigms.

Some conclusions can be drawn from monitoring output, perhaps sufficient to guide government, management, cultural or scientific strategies and policy, but are not implicit in the monitoring system itself.

Broad guidelines based on indicated needs and cultural context are proposed for researchers working on the production of monitoring systems.

Introduction

As we approach the year 2000, society stands at a critical point for making key decisions about the relationship of landscape, agriculture, and society in the future.

We need to address the question "How will we be farming, or grazing, or using the landscape where we live in 1000 years from now?" (after Campbell 1996). Whatever vision we may have individually of this future, whether black and mournful, or exciting, stable, and different, it is obvious that monitoring the state of our renewable resources, and their inputs and outputs will play a key role. Yet it is no easy task monitoring change in ecosystems, such as those found in the rangelands, in a way that provides meaningful information to researcher and land use manager.

There have been many calls for national monitoring systems, particularly in the rangelands, including Harrington *et al.* (1984), and most recently in policy documents such as "Sustaining the Resource Base" (Office of the Chief Scientist 1995) and the "Draft National Strategy for Rangeland Management" (National Rangeland Management Working Group 1996) and descriptions of some monitoring schemes in place now for some time, of which the WARMS scheme in Western Australia would be a leader (Holm *et al.* 1987).

A reasonable answer to the question "Why Monitor?" is that:

"The basic cause for failure to implement sustainable systems is lack of understanding of the water, energy and chemical equilibria operating in our landscapes and a capacity to predict the ways that these will be altered by management." (Williams *et al.* 1993).

Three key questions relate to how to go about the monitoring activity, and the future we plan for it and with it. They require clear answers by any scientist, farmer or grazier, administrator, or conservation manager who sees a role for monitoring in his or her work as a landscape manager.

Consideration of these three key questions in relation to any planned monitoring system design can generate a useful and relevant checklist of items to consider when planning. An example of a more developed checklist is in Appendix 1.

Key questions for designers of monitoring systems

- Who is it for?
- What is it for?
- How will the output be used?

Who is it for?

It is essential to understand and to visualise the individual, as well as the agency, who will actually be using the system.

Is this proposed monitoring for: a science research project; for administrators in an agency concerned with resource use, sustainability or degradation issues; or for farmers to use to lift their profits or improve their drought and wet season management in a sustainable way?

I would like to suggest that for the next few pages that you, the reader of this article, are to imagine that you are about to commission or receive a commission to design a monitoring system.

Have you discussed with your funder and employer the resources and commitment available for monitoring, and are these quite clear to both the employer, and yourself? Is there a definite commitment to do the monitoring long-term, and are there guaranteed matching funds and skills to implement the monitoring you have been asked to provide?

If not, then for your personal satisfaction and in the interests of delivering some useable results, perhaps to another generation, this will need to be discussed and clarified. This may mean that you will have to be prepared to raise the level of knowledge of the agency manager to whom you are responsible.

It is often suggested that monitoring can provide results for two separate groups, for example, to both provide a government agency with state of the environment and degradation monitoring, and to provide a grazier or farmer with pasture production information.

Whenever multipurpose monitoring is suggested, then proceed with great caution, if at all.

Generally monitoring systems designed in this way are seen as, or risk a perception as, "Big Brother" from George Orwell's (1954) novel "Nineteen Eighty-Four", in managing the lives and environments of farmers and graziers. If this occurs, the monitoring system may fail to deliver a useful result to either of the proposed recipients. It may be better to have specifically designed and targeted products that suit the respective needs of the groups rather than attempt a catch-all solution.

In the example above of dual purpose monitoring, it would pay to note that there are considerable value differences between traditional natural resource disciplines and conservation ecology (Heitschmidt and Walker 1996). Failing to address the difference in values and attitudes of farmers and graziers from scientists and administrators (Burnside and Chamala 1994; Williams *et al.* 1993) will often result in suspicion and subsequent failure of the original project and the monitoring system related to it.

This difference in relative values and attitudes between administrators and conservation or production users will mean that the quality and quantity of data collected, while related, will be quite different for each group , and therefore define project design in quite different ways (Beckerling 1993).

Any monitoring design can probably only capture one key strategic purpose.

What is it for?

As the production manager or scientist, the success of the monitoring system that you develop depends on the clarity of understanding that you have as the user, researcher, or developer of the goals of the program of which your monitoring is a part.

The nature of the monitoring should be dictated by these goals, not merely by the available technology, bearing in mind the target "customer" and the costs and time frame clarification that we have sought and established above.

Is the monitoring output to be used for production or conservation, both of these, or some other purpose not imagined at the time of writing this article?

This understanding of the goals and needs of the end user, (not necessarily holding the same focus as the agency preparing the monitoring system) is essential.

A science research project will have a range of well-developed monitoring tools like Botanal (Tothill *et al.* 1992). However, new applications for applied products for the farming or grazing industry would usually require something less complex, perhaps very simple measures based on key elements. So long as the chosen elements are statistically representative of the trend that the grazier, farmer, conservation or landscape manager has nominated as of interest, then it will be appropriate.

Simplicity in itself is desirable in monitoring (Walker 1976) and is likely to ensure the durability of the monitoring system and related project over time. Simple measures, as in the case of the recordings taken in saltbush country in South Australia in 1948, recently compared to site readings taken in 1971, *can* be clear indicators of trends of interest or concern. (Maconochie and Lay 1996). When systems are simple and outputs clear, information derived from monitoring delivered in a way that seems useful to the producer will be sought after and used. (Jessop 1996).

A continuing challenge for any monitoring system designer will always be the viability of the interpretive framework in which the modelling is used. If change is the only certainty in science and life, is the system for monitoring that is emerging in your mind robust enough to cope with a change in philosophy or paradigm in the next 20 years?

In the rangeland, discussion on the two prevailing equilibrium paradigms continues (Mentis *et al.* 1989; Petraitis *et al.* 1989) as the concepts continue to be scrutinised for relevance in interpretation. Serious and practical consideration has to be given to this issue, as it can impact on the technical design of the monitoring.

"*Failure to recognise the hierarchical nature of ecosystems and the emergent properties of each level, means that we run the risk of collecting vast amounts of information at the wrong scale, which we are ultimately unable to interpret*" (Friedel 1994).

The final use for the product that is based on monitoring will also have a bearing on the technical issues of spatial scale, time and frequency of monitoring, and measurement precision. Different end products require different levels of concern with each of these key elements (after Wilson 1989).

Obviously some considerations are universal to all outcomes and products, such as the need for the designer of the monitoring system working in a rangeland ecosystem to recognise the importance of landscape context and site location (Ludwig 1995; Tongway 1994).

Whatever the range of methods and philosophy, the monitoring system designer will have to attain a clear view of the likely final use of the monitoring data.

How will the output be used?

Although the use of the monitoring system may be well removed in time and location from the monitoring designer, the effort to try and visualise the physical product as well as the end user is worthwhile to help ensure final project success.

For example, the product could be for a grazier to help him or her to calculate a feed budget, and therefore be any or all of: a worksheet, manual or computer programme.

If so, then dry matter yields at appropriate times for that region may be all that is required, with little concern for the change in species mix that make up the pasture.

If the final user is a manager for a conservation agency, then quantitative yield estimates may be of little interest and seldom used. However, a whole complex of soil and water biophysical characteristics, and floral and faunal frequency and abundance measures may be required. This data in turn might

Plate 1.1. Grazing management will have long-term effects on the condition of pastures. Monitoring can give early warning of impending change.

be used by a range of agencies for various purposes, rather than single once-off seasonal decisions.

For the end-point or final product for any monitoring work, how can the resource manager use Ockham's Razor (Russell 1959)? That is 'What is the barest minimum, best quality, simplest recording that the user can do that will provide the monitoring data for the primary project goal, through thick and thin, funding and no funding, expertise and no expertise by recorders?

Contemplating and planning carefully for the final end use, and the human users, is really an essential part of the monitoring designers planning.

As a guide, a rough "checklist" of items and considerations for monitoring systems is given in my Appendix 1.

Monitoring technology

For the three key questions, the issues of available monitoring technologies have not been discussed in any detail.

As it seems that society, scientists and producers are all equally obsessed by technology, it can be fairly assumed that most monitoring designers will embrace the tools and toys of technocrats with a vigour that would make a Luddite blush.

Technology and emerging technologies clearly have a role to play in the monitoring process. However, in the same way that monitoring is merely a tool to another end, technologies are only tools for the use of system designers. All available products for use in monitoring will need to be assessed on simple criteria of relevance, benefit obtained for cost, simplicity, and durability.

It *is* important for the system designer to have a full and complete inventory and understanding of the monitoring tools and concepts, their reliability, and their acceptability within the discipline that the designer is working in.

Choosing a technology (inevitably the latest and brightest product) first, and designing a system around it, is not uncommon, but it is not necessarily a logical or useful way to provide a lasting and effective system addressing the original needs.

The language of monitoring

For some time concern has been expressed about the language of monitoring (Laycock 1989) and even new nomenclature systems for states suggested by Pendleton (1989), who, (writing from a Clementsian viewpoint in the USA), offered:

"..that if condition classes are to be used, they should be four in number and that they should have names with ecological connotation rather than value judgement. To replace the current condition classes, Range Inventory Standardisation Committee (RISC) suggests use of early- seral...mid-seral, late-seral and potential natural community."

In Australia (and writing from a state-and-transition viewpoint), this has been canvassed in the Tothill and Gillies report, where the authors used three classes to define condition states—pristine or desirably sustained, deteriorating, and degraded.

Tothill and Gillies specifically warned, and highlighted in italics, that it "*is important that the assessments of degradation at the second state (deteriorating) and the third (degraded) states be kept distinct. They must not be added together to make unqualified statements such as '60% of Australia's grazing lands are in a state of degradation'.*"

The authors note that the "*deteriorating*" state was intended for those pastures which were sufficiently disturbed as to be at risk of movement to the third condition state in a major climatic event, such as drought, or a continuation of mismanagement.

This second state is, therefore, quite clearly defined and appropriately captures a common condition in the rangeland of landscapes at varying degrees of risk prior to major state changes.

The 'deteriorating' category might often reflect that:

"*Changes in biodiversity, which may appear to be degradation can, in some cases, be ecosystems responding to naturally-induced stress and variability. Any measures of loss of biodiversity related to degradation will need to cope with dramatic natural temporal and spatial damage.*" (Pickup *et al.* 1994).

Despite the careful warnings to readers from Tothill and Gillies, it is interesting to note that in the current Draft National Strategy for Rangeland Management (NSRM) that the first table in the book refers to the Tothill/Gillies states as:

Table 1.1. Comparison of condition descriptions

Tothill/Gillies description	NSRM description
Pristine/desirably sustained	Good condition
Deteriorating	Degraded, but recoverable
Degraded	Degraded, not economically recoverable

This description by the editors of the NSRM of the second condition state only barely respects the injunction in the Tothill and Gillies report.

Rangeland scientists deal with a powerful landscape that has very high emotive value for many in the Australian and American urban public. McIntosh (quoted by Smith 1978) maintained that:

"*Clement's community and succession concepts were lineal descendants of a long tradition of natural philosophy which held that there were design, purpose and unity in nature, and that these required a holistic approach to their understanding*".

Language in this area of science has become inextricably linked with philosophy, and this is a problem which requires serious attention and consensus. While physicists, like any scientists, have their polemics over hypotheses, are they ever concerned about the philosophy or values attached to a quark?

There is a need for a new language for monitoring and for processing of results.

Monitoring and values

While few people would doubt that scientists are influenced by prevailing cultural mores, and "*research itself is a social process, and neutrality is a facade. Research using communicative acts cannot be value free*" (Shulman *et al.* 1994), and no research activity has been cursed more freely with the weight of past and present lexical inadequacies than ecology.

I suspect, within ecology, that the study and administration of the rangelands, which have carried with them the ethos of open spaces and independence, and a whiff of saltbush and sagebrush, have suffered most from a failure to agree on values and use by society.

Monitoring will not solve the issues or values or use that any individual or group, urban or rural, may have concerning the rangelands.

Monitoring is merely a tool that will provide hard data.

A related and difficult issue is to resolve the language in which results are analysed and reported.

"*We will need for ever to be wary of views that assert that science is what its political implications are, rather than what its experimental findings are, that the truth is revealed in rhetoric and metaphors used by its practitioners rather than their mathematical equations, is of course a convenient one for academic humanists and others who may be ill-equipped to*

Plate 1.2. The condition of pastures under woodlands will deteriorate unless fires are managed. Monitoring can pick up trends and changes so that managers can act in time.

understand those experimental findings or mathematical equations. No one denies that culture influences scientific thought. But some things hold whether one believes in God, the Enlightenment or Ronald Reagan" writes a former editor of 'Nature' magazine (Budiansky 1995).

It remains immensely important that key and controversial values (for instance, the value that society places on biodiversity) are resolved in another public forum. The role of monitoring is to provide the data, and the place of scientists to provide the interpretation that will generate the evidence of the trends that will be essential material in this often emotional debate.

Monitoring and conservation

Measuring biodiversity, to establish the composition and abundance in the rangelands on any of the three spatial scales suggested by Pickup *et al.* (1994), requires considerable resources and future commitment.

However, because of the event-driven nature of the rangelands, the role of long-term monitoring is probably most important for conservation concerns.

Because of the importance of thresholds of change in the rangelands, it may be more important that the monitoring system provide information that will generate reasonably accurate estimates of trend and change, rather than concentrating on the absolute accuracy of individual site descriptions.

Perhaps one small opportunity for those monitoring biodiversity and particular species is to use (where this is available) the aboriginal inhabitants' skills and memories to extend in a subjective way the temporal scale of knowledge.

An example is the research published by Baker (1992) with the Mutitjulu Community in the Northern Territory. This provided an extension of knowledge from oral tribal sources, offering a window back to the drought and hitherto unrecorded extensive disappearance of species in 1930.

Given economic constraints, it would seem that conservation monitoring may have to concentrate on key landscape points (such as grazing gradients or selected biosphere points) and/or simple monitoring techniques based on key indicators, such as key species, basal area, bare area, which will provide the best indicators (however inadequate) of the state and trend of the system.

Some worthwhile future research would establish strong relationships between species and, over time, to identify the necessary critical indicators for particular systems.

Monitoring and primary production

Monitoring for primary production will be different because:

- primary producers are an extremely diverse group with a wide range of business, technological and agricultural skills.
- most primary producers in NSW and Queensland are unlikely to have heard of monitoring or why monitoring is done.
- many producers are likely to feel some competitive element in the exercise of monitoring and perceive this as a threat to their own management skills.

Plate 1.3. Gradual encroachment of the native mimosa bush (Acacia farnesia) can be monitored easily with photographs.

Table 1.2 'What is the primary management objective? Two perspectives on the same question (after McLeod and Taylor 1994)

What is main aim of beef cattle producers?	Respondent group	
	Beef producers (%)	Research scientists (%)
Maximise production	27	17
Maximise profit	28	53
Enterprise survival	20	10
Maintain land resource	11	0
Other	14	20

Table 1.3 'Which group knows how to develop sustainable systems? Two perspectives on the same question (after McLeod and Taylor 1994)

Who knows best?	**Respondent group**	
	Beef producers (%)	**Research scientists (%)**
Experienced beef producers	51	26
Research scientists	21	65
Other	28	9

This last point is because, once monitoring is explained, primary producers will already have a perspective from their own experience on land condition and trends—unlike groups such as ministers and staff of Departments such as Natural Resources or Environment in Queensland.

Monitoring for primary production purposes that does not take account of the attitudes of primary producers, and that is not strongly driven by concerns about security, sustainability, profit or equity, is unlikely to be adopted except by an extremely small minority of primary producers.

Tables 1.2 and 1.3 from McLeod and Taylor (1994) show clearly this difference in values and attitudes.

The overall aim of these researchers was to establish an understanding of the perceptions and differences in perception of beef cattle producers and scientists relating to sustainable land use issues and their implications for technology transfer.

Producers and scientists were separately asked an identical set of questions which concerned "*What is the primary management objective of the 'majority' of beef producers in Queensland?*" Table 1.2 shows a considerable divergence of view between the actual users, the beef producers, and the researchers or advisers.

While the results demonstrate that the majority of scientists (53%) in this project feel that producers are strongly motivated by profit, producers in replying to the identical question, indicate that they are almost equally concerned with production (27%) as with profit (28%), and are almost as concerned with enterprise survival (20%), presumably in a way *not* reflected in profits.

The project asked producers and scientists "*Which group has the knowledge appropriate to developing sustainable systems of grazing land management?*" The results posted in Table 1.3 seem to reinforce a very fundamental attribute of human nature—egocentric certainty—as it shows very clearly that scientists (65%) and graziers (51%) both have a burning conviction of their own capacity to have the knowledge to develop sustainable systems.

The producers appear to evince a marginally less determined view than the scientists about who has the right answers, and are more open to suggestions from "others" (28%).

The lack of awareness, amongst the majority of producers, of the various roles of monitoring, will preclude the question "*What could or should I use monitoring for*?" being asked.

The questions that the landholder will be asking will be more in the context of: "*How do I get through the next drought?*"; "*How can I stabilise my financial position or improve my profitability?*"; "*How can I ensure that I will be here next year?*".

Some examples of real-life situations would be:

- monitoring of dry matter yields at key decision times to objectively establish reserves of feed for normal operations
- extraordinary operations such as additional livestock purchase (short-term) to take tactical advantage of a bumper season
- appropriate feed allocations to key livestock classes (pre-natal, lactating, weaning)
- a feed budget strategy to combat droughts and seasonal uncertainty by matching standing reserves and predicted pasture yields to total grazing pressure, based on monitoring outputs combined with a knowledge of rainfall probability.

In leasehold situations where Government and community hold title, there may be a sound incentive for producers to voluntarily demonstrate that long-term sustainable practice is in place.

The warning earlier in this article, which concerned the gathering of information for both government agencies and farmers still applies. Where this is attempted, "*a very clear and symbolic distinction must be made between the purposes and intended uses of these levels. They must be represented as functionally very different. For instance, perhaps the word 'monitoring' which has an ideology, a history and a story in the rangelands should be replaced by another term of use in respect of the processes used by landholders*" (Burnside and Chamala 1994).

To all parties, transparency of the various uses that will be made of the monitoring output is important.

Interpretation of monitoring results for producers

The consideration of the three key questions in the checklist proposed earlier becomes important in the light of the indications from Tables 1.2 and 1.3 after McLeod and Taylor (1994). In terms of "*Who is it for?*", producers will approach monitoring with attitudes that are quite different to members of the scientific community.

Work by Gary Bastin with a Northern Territory pastoral family on the use of satellite information to detect landscape changes and resilience, produced the following comment relating to the adoptability of the outputs that "*the technology was not embraced as enthusiastically as we might have hoped for. This diminished success was due to the complexity of the technology, our inability to suggest definitive land management options, (if indeed they do exist) and differing approaches to assessing vegetation response to rainfall*" (Bastin *et al.* 1996).

This is an example of the range of differences in approach by scientists and producers.

For the question "*What will it be used for?*", a careful examination of the available interpretation packages would be worthwhile to ensure that any proposed monitoring system is linked to some output to help ensure that the monitoring is relevant and durable.

One example of such a package is GrazeOn, developed in the Department of Primary Industries in Queensland by Cobon and Penington (1996), and recently released as a pilot software program for rangelands use. This package provides feed budget estimates from photo-standards (or other inputs), in terms that appear to relate to grazier management parameters. Other packages relevant to their regions are being developed in other locations.

Further discussion on the development of simple techniques for biomass assessment and the relationships between satellite information and ground use is to be found in Appendix 2.

Summary

- key technical points

Monitoring is a tool. Its use must be clearly understood when the system is being designed.

Monitoring must be simple and robust, and able to respond to changing financial circumstances.

For primary producers to adopt monitoring, it must result in products that are oriented to producers' values and that can improve sustainability, stability or profit.

- other important issues

- Monitoring should include key inputs and outputs (e.g. rainfall, seed-bank), not merely describe states. Collected data should be adequate to indicate trends.
- The common neutral language should accurately describe change, but not include emotive or social values
- Measuring does not confer or confirm values.

Monitoring as only a tool cannot in itself answer complex and often sociological questions, such as the relative value of biodiversity versus value of production or the resolution of differing perceptions of ecosystem stability.

These are all important questions that society needs answered, and serious attention is required in another forum to address these issues.

Conclusion

If we plan our future by monitoring our productive ecosystem resources and trends in their condition, the inputs to the system, and the results of any changes, then there is no reason why we could not be grazing and farming these lands in another 1000 years.

Plate 1.4. It is not always necessary to monitor to know when a paddock is overgrazed.

Appendix 1

Checklist for designers of monitoring systems

The following is a checklist to be considered before monitoring:

Goals. Do you have a clear picture of your goals, of which the monitoring is only a part?

Scale. The spatial scale of monitoring is likely to dictate the tools used.

Variability. The spatial variation in the landscape may need to be monitored at all scales, in the rangelands, usually between run-off and run-on areas. This poses problems of site selection for the managers, farmers and graziers.

Accuracy. What degree of accuracy will serve the purpose of your primary goal?

Ecological scale. Do you need to assess the full spectrum of plant and animal diversity, recording abundance and change for each plant, animal, insect, soil microflora and fauna, soil composition? Or can key indicators signpost the general trend of the whole system?

Time scale. Do you aim to detect short-term or long-term change?

Time of monitoring. Will the nominated attributes be best measured after major rainfall events or on fixed key dates each year? Or biennially or triennially? Why?

Tools. What tools do I have to work with? What are the latest most effective tools and concepts, their cost, their reliability, their acceptability by others.

Costs. Who will pay for any long-term commitment to monitoring, and how secure is this funding?

Sites. Who owns the land? Do you have legal access to the sites for the long term, or do you depend on the goodwill of the landowners? Are the landowners likely to change? Do I need special agreements or easements? Is one of my options not to monitor if I cannot guarantee a time frame for access that delivers the results I have defined as my goal?

Design. Can the system be managed and recorded by the existing or future human resources and skills if I am not available?

Paring. For my goal, where can I apply Ockham's' Razor? What is the barest minimum, best-quality, simplest recording that will provide the data for my primary goal?

Appendix 2

Monitoring for primary producers must:

- address the needs, respect the context
- use simple, easy-to-use tools
- have clear interpretation of results.

Address the needs

For primary production monitoring, a very hard and sharp examination of the likely use, users, and interpretation intentions of the end users will be required to ensure the simplest most effective monitoring is undertaken.

John Tothill has noted (pers. comm 1997) that the management objectives are not simplistic, but quite complex with each class of livestock, (for example, lactating, young weaned animals, dry animals). Each has a different nutritional requirement that in turn may require different monitoring objectives at different times of year. This subset of goals in turn intersects and reacts with rainfall seasonality and market requirements for livestock condition at turn-off times.

Any monitoring system should provide useful guidance and tools for each of the livestock class goals, and offer relevant information for each tactical decision. This is not to suggest that there would be a multitude of different monitoring systems but rather that the design of the monitoring should address the various needs.

A final important requirement of any system is that it should result in simple records which permit an analysis of long-term trends of concern over time that can easily escape subjective short-term observations. Examples are a steady increase in woody weeds, or changes to less palatable grasses or loss of the most palatable species of bluebush. Such changes are often not detected in normal ways until critical thresholds have been passed.

Short-term recording should produce a long-term description of trend.

Simple tools

Technologies

Simplicity does not exclude technology. The paper by Bastin *et al.* (1996) quoted earlier, also contains the observation by the graziers in the study that they see "*the resilience mapping (satellite) technology as having its greatest value as a monitoring tool, and particularly a way of complementing the information that they are presently obtaining at ground-based sites*".

Satellite monitoring appears an ideal adjunct to ground sites, and the author is involved in developing a ground and satellite based system that is relevant to needs. It uses both technologies to produce the desired result on stations owned at Blackall in central western Queensland. There appears to be no difficulty in finding cost-effective sky-based platforms that provide useful images for any areas of interest. However, there is little technology on the ground that can be used in a friendly manner that quickly and simply provides a site assessment for grazing purposes.

We live in an age when at the push of a button a farmer can press 190 kg of wool without effort, send a fax of several hundred thousand data bits, or activate a PC-run accounting program. The average rural manager, like her or his urban counterpart, has become technocentric, and seeks simple devices to perform complex tasks, or to assist with objective inputs or to achieve actions.

In writing and consulting for this paper, grazier and agricultural scientist Andrew Nicolson suggested that, if it was possible, a tool or device which assessed range condition by "taking a reading" would be worthwhile and sought-after by primary producers if effective. This is an area that for the grasslands at least might be worthwhile researching.

Excluding manual and mechanical quadrat-related cutters, several devices have been tested in the past:

1956 Fletcher and Robinson - electrical capacitance devices.

1966 Teare, Mott and Eaton - beta attenuation from radioisotope sources.

1970 Jones and Haydock - Capacitance tested again and developed a "pasture meter".

1972 Mitchell - the first field trial of beta-attenuation with quite good correlation achieved.

1973 Pearson and Miller - biometer - short-wave reflectance spectral analysis . Quite good correlations achieved and some progress made (all 5 above after Mannetje 1982).

1996 Holt *et al.* (1996) - microbial carbon biomass assessment to analyse patchiness in vegetation.

Techniques

There are sound pasture sampling techniques for research use, such as Botanal. However, for on-property measurements of pasture grazing use and management, simpler and easier monitoring and assessment techniques are preferable. Some suggestions are:

Indicator species

Depending on the end product required, sometimes a monitoring system might use indicator species (presence, absence or utilisation). In a gidyea *(Acacia gambagei)* association in Blackall, the author uses the shrub "broom bush" or "currant bush" *(Apophyllum anomalum)* as a guide to paddock utilisation in certain frontage/gidyea marginal areas. These are locations where there is little bulk of grass, and guides are needed to assist with stocking/destocking decisions. When, after a period when the shrub is not browsed at all, livestock start to utilise the shrub, then substantial destocking in that paddock will be required within no more than 2 weeks.

Fuel accumulation

Perhaps, in the wetter tropics, a sufficient monitor or guide to direct pasture management is the accumulation of sufficient fuel to burn pastures once every 2–3 years. This could be visually assessed for biomass, (or with the aid of a height/density chart, if proven to be accurate, useful and relevant.)

Photo-standards are available for yield assessments, such as standards in the useful grass management series released by the Queensland Department of Primary Industries are exemplified Partridge (1995). A more accurate measurement can be obtained from using photo-standards where results and standards are "calibrated" for the user. This calibration implies the availability of qualified staff with interpretation and education/training skills, not necessarily readily available in remote areas. Photographic records do have the benefit of being subjectively comparable, and able to indicate trends.

Grazed-class photo-guides, where biomass is estimated by the proportion grazed or remaining have been tested by researchers in the USA (Schmutz 1978), but the author was unable to discover whether they were commonly used in the field by land managers. These techniques have been investigated in Australia in plots (Anderson *et al.* 1994) but appear not to be relevant to many Australian pastures. In the experience of the author, the reality of pasture grazing by animals is that the uneven distribution of forage species, combined with unpredictable dietary choices by animals, leads to a mix of pasture heights even in relatively homogeneous communities such as Mitchell grass *(Astrebla* sp.*)*.

Plan the end product

Examination of the available interpretation packages would ensure that any proposed monitoring system can be linked to some output—as in the GRAZEON package of Cobon and Pinington (1996)— to ensure that the monitoring is relevant and durable.

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