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Monitoring as an integral part of management and policy making

Bosch, O.J.H. boscho@landcare.cri.nz, Allen, W.J. & Gibson, R.S.

Manaaki Whenua - Landcare Research, PO Box 282, Alexandra, New Zealand [Source ..... Proceedings of Symposium "Resource Management: Issues, Visions, Practice"Lincoln University, New Zealand, 5-8 July, 1996 pp. 12-21]

Introduction

Monitoring can be defined as the periodic remeasurement of appropriate parameters to determine the effects of particular management strategies or policies, and the response of systems to changes in the wider environment. The results of these assessments can be quantitative in the form of data and information or alternatively qualitative, based on subjective observation. This will depend on the methodology being used for the monitoring programme.

In the business world monitoring is accepted as an integral component of decision-making in a complex and uncertain world. However, this is not always true for the management of our natural resources, despite their importance to humanity. Many environmental monitoring programmes fail to become an integral part of management because they are not designed to help decision-makers.

One of the most common reasons for designing a monitoring programme is to meet a regulatory requirement, for example state of the environment reporting, sharemarket listing, lease requirements. Another reason is the need for a particular permit holder, a land manager or company to obtain data as a protection against action by a regulatory agency or other interest groups. An equally important reason is to help companies, land managers, conservators, policy makers, and other decision makers to design procedures to minimise the impacts of particular adverse effects, or to help them in steering their management to achieve particular goals or targets.

The first two reasons would apply to most of the environmental monitoring programmes being carried out at present. Unfortunately, environmental monitoring programmes are rarely designed for the third reason. It is becoming increasingly recognised, however, that monitoring is needed for decision-making if we are to manage our natural resources successfully. For example, a report by the Parliamentary Commissioner for the Environment (1995) stated that ongoing monitoring by land managers is essential to increase the understanding of issues affecting tussock grasslands. The same report also stressed that decision makers and land managers need to promote and adopt management approaches that are based on both research and monitoring results.

The success of a monitoring programme that is integrated with management would be highly dependent on the availability and accessibility of knowledge on how to achieve pre-dertermined goals and targets. The question arises, where will all this knowledge come from? Although science is continuously adding to our knowledge through research, the complexity of the systems in New Zealand makes it impossible for scientists alone to develop the required comprehensive knowledge base. This is where land managers and policy-makers can play a most important role, adding new information to the knowledge-base through a well designed monitoring programme. Monitoring and adaptive management enable land managers and policy makers to become directly involved as "researchers" (Bosch et al., 1995). This is learning by doing. Finding out about complex and dynamic situations, then taking action to improve them, forms the basis for this learning process. Such an approach clearly makes monitoring an integral part of management and policy making. Without this "experimentation" dimension, and the ability of the monitoring programme to maximise the usefulness of data, there will be no guarantee that the results can be used in management and policy making, and monitoring becomes monitoring for the sake of monitoring.

This paper describes the key elements of a successful monitoring programme to help those entrusted with the responsibility of managing our natural resources. It will also illustrate how these elements can be brought together within a robust framework. Finally, an example of such a monitoring programme in the South Island high country is provided and evaluated against the required elements for successful monitoring.

A framework

A monitoring programme, which forms an integral part of management, requires that:

- the issues, goals and targets are known (why and what to monitor),
- monitoring tools are available to assess and interpret the outcomes of implementing the strategies or policies, and
- the options and strategies to achieve these goals are directly accessible by land managers and policy makers,
- the usefulness of new data and information from monitoring activities is maximised, not only to serve as a basis for adaptive management, but also to enhance the existing knowledge-base available to land managers and policy makers.

These four basic requirements have been integrated in a systems orientated and participatory approach, which can serve as a framework for the development and maintenance of long term monitoring programmes.

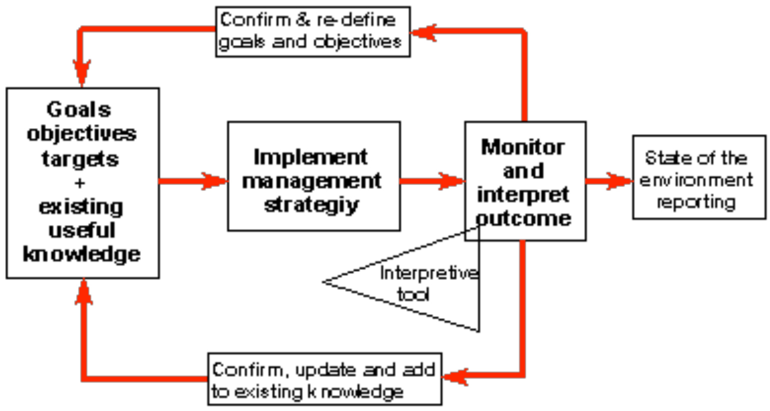

Figure 1. Framework that incorporates the main characteristics of a successful monitoring program.

Identifying the goals .

The first step in developing a successful monitoring programme is to define clearly with those involved, the stakeholders, the nature of the system under consideration. This will serve as a basis for determining the needs of the different interest groups involved, and the specific goals and targets they wish to achieve. These will not only determine why the monitoring is to be carried out, but also what is to be monitored. A lack of well defined goals often leads to the gathering of long term monitoring data of little use to management. Examples can be found in the many monitoring programmes in which only the main components of vegetation (e.g. grasses, herbs, woody species) are measured, whereas even the most common goals for monitoring, such as the effects of management on biodiversity, production and conservation, require the the measurement of parameters such as the change in total composition, palatable species, and/or indicators of condition.

Availability of monitoring tools

If land managers and policy-makers are to be encouraged to become formally involved in the monitoring and adaptive management process, they require access to user-friendly monitoring tools, and most important, information on how to interpret the results. The nature of monitoring tools that will help interpretation is determined by the reasons for monitoring and the goals and targets to be achieved.

As an example, the High Country Committee of Federated Farmers (1994) has put together a farmer resource monitoring kit with details on various methods that individual farming families can use on their properties for monitoring. This is a valuable tool to standardise the methodologies available for monitoring, and the data that will become available. Standardisation is an important step towards the development of a common "language" between different interest groups.

There has been considerable progress in the development of monitoring methods. Using rangelands as one example, scientists have developed various sophisticated, quantitative techniques for monitoring vegetation and soil changes over the last three decades (e.g. Foran et al., 1978; Vorster, 1982; Stuart-Hill et al, 1986; Hurt and Hardy, 1989; Bosch and Gauch, 1991). However, despite the efforts invested, the world's rangelands continue to shrink due to processes such as degradation and desertification. In many cases the problem is not so much that science is lacking, but that scientific understanding of the degradation processes and causes has not been translated into practical application. The apparent inability on the part of land managers to make use of monitoring data can, at least partly, be attributed to the lack of tools to make sense of, and interpret monitoring data in a useful and efficient way. For example, the Nevada Rangeland Monitoring Handbook (1984) amply describes monitoring methods and techniques, as well as providing definitions of terms used in range condition assessment. Unfortunately, little or no space is devoted to explaining what to do with the data, or how to interpret it once it has been collected. The result is that very little monitoring is today carried out in the rangelands of this area.

The availability of interpretive tools is a prerequisite for a successful monitoring programme. An example of such a tool is the computerised Integrated System for Plant Dynamics (ISPD) (Bosch et al.,1992), which provides land managers with a user-friendly system to assess and interpret vegetation condition. The system combines various concepts in vegetation dynamics, such as successional change, state and transition models, thresholds, and key indicators of condition as a basis for interpreting the monitoring data.

An example of a less sophisticated but useful interpretive tool, is the water quality monitoring data sheet that has been developed by the Otago Fish and Game Council (Wright, M. pers.com.). Fresh water indicators are tabled in order of their expected occurences on a gradient from good to poor water quality. Their abundances or presence at a particular water sampling point can be directly related to the quality of the water, as they serve as indicators of different positions along the gradient.

Availability of a knowledge base

As mentioned above, a prerequisite for a monitoring programme that forms an integral part of management is easy and direct access to available and useful knowledge when it is necessary to respond to monitoring outcomes.

In general, a large knowledge base already exists for most of the issues managers deal with. Years of experience have provided land managers and policy makers with a wealth of knowledge of their local systems. Unfortunately this information is rarely documented, nor is it available to decision makers on a collective basis. Similarly, much of the valuable knowledge that scientists have accumulated is fragmented, held in different databases, and consequently not always readily available.

Bringing local and scientific knowledge systems together into a single accessible and structured Decision Support System (DSS), can provide land managers and the wider community with a valuable knowledge base to help decision-making. They would gain direct access to useful knowledge without having to rely solely on fragmented bases of knowledge and experience. Given that our knowledge of natural systems is, and will always be, incomplete, Bosch et al (1996) and Allen et al (1995) suggested the development of a prototype DSS, which can be enhanced over time by ongoing feedback and learning.

Maximising the usefulness of monitoring data and information

Monitoring data and information are firstly used to assess the outcomes of a particular management strategy or policy. They also serve as a basis for active adaptive management, in that the outcomes determine whether a modification of apllied strategies is required to achieve a pre-determined goal. A further, most important aspect, is the use of the data and information from the monitoring process to enhance the existing knowledge base available to managers and policy makers. This would add to the direct benefits of the task of monitoring, and serve as a further incentive for continuous involvement.

Implementing a management scheme or policy is always an experiment. As land managers and policy makers measure the outcomes of their actions or policies, they continually gain new "experimental results". These outcomes provide new information whereby the knowledge base can be re-evaluated and expanded in collaboration with scientists and other stakeholders. In turn, the enhanced knowledge base provides a broader foundation to help individual land managers and policy makers with future decision making. This knowledge enhancement process requires that the data and information from monitoring be captured in a pool, where it can be processed for the next important step, i.e. to transform the monitoring results into useful knowledge at different scales, from the block/paddock, to catchments and regions.

Community dialogue and co-learning during combined workshops with decision makers and researchers is proving an effective way to transform data and information into useful knowledge (Allen et al. 1995; Bosch et al. 1996). The community dialogue process is designed to seek the active cooperation of participants in developing a common understanding of the context in which any individual piece of information becomes relevant. The outcomes of these workshops are then made available to the wider community in updated versions of the existing knowledge-bases (DSS prototyping) (Bosch et al. 1996).

Involvement in the participatory processes of monitoring and adaptive management in this way allows individual land managers to acquire greater technical expertise using both local and scientific knowledge. At the same time, by achieving specific objectives for improving their resource position through a collective effort, land managers develop greater confidence as "research providers", which ensures the successful continuation of their role in the process.

The Hieracium Management Programme: A successful monitoring programme ?

Over the past four decades Hieracium species have spread significantly throughout much of the high country, and appear likely to continue to increase at the expense of both native biota and introduced forage species (Scott, 1984). They are most common on pastoral lands, and have a detrimental impact on farming enterprises through an associated decrease in productive capacity (Martin et al., 1994). Conservation values are threatened in a similar manner. A recent survey classified their abundance through 1,500,000 ha of this area (around 10% of the South Island) as sufficient "to characterise the appearance of the vegetative cover and to be among the main species present" (Hunter, 1991). Over a third of this area Hieracium species were recorded as being dominant, in some cases even comprising effective mono-cultures.

A number of recent reviews and workshops have investigated the role of Hieracium in the South Island high country (e.g. McKendry & O'Connor, 1990, Hunter, 1991, NZ Ecological Society, 1992). However, as Rose (1992) observed, "most would agree that the issue is complicated and that simplistic or single-factor explanations have resulted in much apparent contradication". Any model to explain the role of Hieracium in tussock grasslands not only needs to account for the complex interaction between current management regimes, but also to consider spatial and temporal influences such as history, climate and altitude. A further consideration is that the successful uptake of any strategy by land managers which appears to reduce the likelihood of Hieracium increase will be dependent on its perceived relevance and compatability with other concurrent farm objectives.

From the above it was clear that a participatory approach was required to address the Hieracium problem. This was achieved by involving the community in defining the problem, identifying the goals and targets of land managers, and sharing existing local and scientific knowledge on how to address the problem and achieve these goals. The outcome of these processes led to the identification of various knowledge gaps and new research priorities. Due to the complexity of the high country systems, it was regarded as impossible for scientists alone to provide this knowledge. The process of monitoring and active adaptive management was seen as a means by which the community could also add to the knowledge pool. For this, a monitoring programme has been designed that will not only test the existing management strategies at various locations in the high country, but will also be used to obtain new data and information to enhance the existing knowledge base. The degree of success of the programme, is tested against the four basic requirements of a successful monitoring programme.

Do we know why and what to monitor?

Given the complexity of the problem, it was important to concentrate first on defining the context in which the Hieracium problem should be addressed. This served as a basis to define the specific goals and objectives land managers would have in addressing the problem. Hieracium was seen as only one component of the overall vegetation cover, and management can not be focussed on Hieracium per se. Accordingly, farmers and conservators defined their goals in practical terms: For farmers the issue was how best to manage their vegetation to maximise the availability of palatable species for production purposes through improving the palatable species component, and through reducing or controling the rate of Hieracium spp. invasion; conservators were mainly concerned with maintaining representative native ecosystems.

Is a monitoring tool available?

Because the focus is not only on Hieracium species, but rather on how the dynamics of total vegetation compositions vary with management and other environmental impacts, a user friendly computer tool was developed, based on the concept of the ISPD (Bosch and Gauch, 1991), to serve as a basis for the interpretation of compositional changes, including the role of Hieracium invasion. Interpretation of the condition assessment is conducted in conjunction with a descriptive model (graphical display) of vegetation changes along a gradient of increasing pastoral impact (Figure 2). The assessment involves the incorporation of a new site from a particular habitat or ecological area into an existing degradation model for that area, using the key indicators of condition (Gibson and Bosch, 1996). The position of the site/paddock on the gradient (and its condition value) in a particular year (say 1995), provides an indication of its condition at that time, how it changed (say from 1991), and what is likely to happen if the pressure on the system is changed (using the graphical display of changes in different components along the pastoral impact gradient).

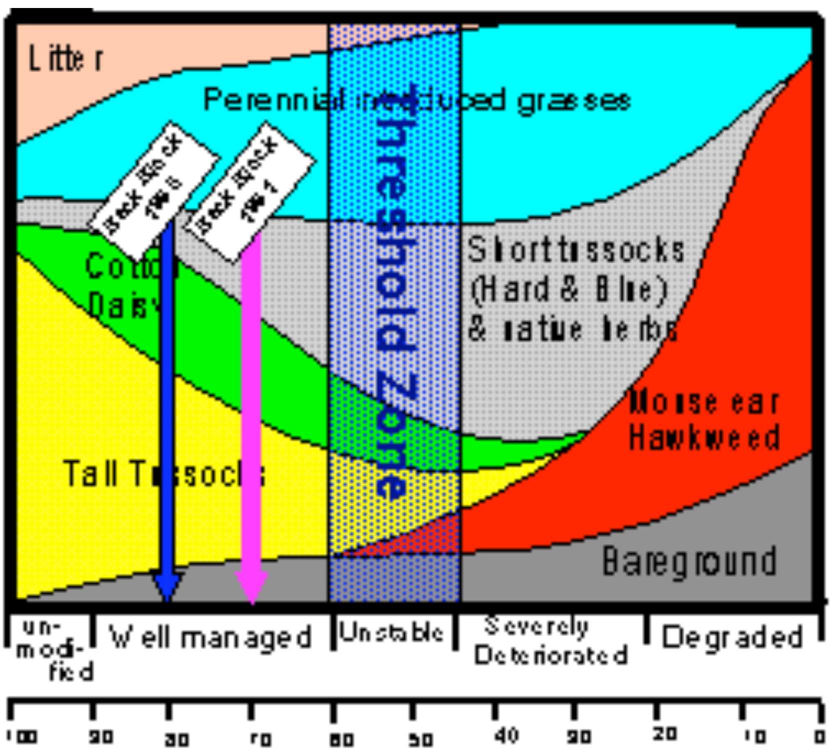

Figure 2. Example of a condition assessment model adopted from Gibson and Bosch (1995).

The existence of a possible threshold after which the process of degradation becomes irreversible, is incorporated into the assessment models (Bosch, 1989; Friedel, 1991). This threshold plays an important role in management decision-making, by indicating when the resillience of the system will be exceeded, which will change the nature of the management response needed to improve the condition. These thresholds are determined and verified through detailed vegetation and soil studies, and the analysis of existing long term monitoring data.

Easy access to knowledge on how to address the problem?

As we have already indicated, vast amounts of knowledge about any issue is collectively held by the the local community and science. The difficulty is that both are usually fragmented and often not documented, and land managers and scientists have had towork together to combine local and scientific knowledge in a DSS.

The knowedge-base held by local land managers was initially accessed using in-depth interviews and comprehensive mail surveys, offering all high country farmers the opportunity to share their thoughts and observations. This information was then structured into a document which outlined the "best bet' strategies farmers felt could help achieve their management goals, as well as the reasons and implications of this within the total farm system. This document was reviewed by a team of scientists (reviewing current available literature and interviewing researchers) to confirm or refute the knowledge supplied by the farming community, and to add new ideas and strategies developed from research.

Once science and local knowledge of Hieracium had been combined, a series of workshops involving both farmers and scientists were held throughout the high country. These workshops were designed to produce "useful knowledge" to help all those involved with the process. This useful knowledge was structured into a Decision Support System, that had been designed and developed with the help of the communities it has to serve, in this making the knowledge available to the wider community.

Will usefulness of monitoring data and information be maximised?

At this point, the first three requirements of a successful monitoring programme have been complied with. However, the strategies available in the knowledge base by which Hieracium could be expected to be avoid or reduced, can further be tested through implementation and monitoring. One hundred sites with varying degrees of Hieracium infestation have been selected throughout the high country. These sites will be managed in different ways, using the existing knowledge that was created during the community dialogue and co-learning processes. The outcomes of these management strategies will be monitored by land managers themselves, using the indicators and condition assessment models applicable to the specific area.

The results of the monitoring will, first, serve as a basis for changes in the management of the sites, should these be required. That is, due to the availability of an interpretive tool, the results will be immediately useful for management. Second, processes are also being put in place by community organisations and Regional Councils to capture this new data and information, and transform it into useful knowledge that can be used to enhance the existing knowledge base.

Concluding remarks

This paper has argued that if monitoring is to contribute to the adoption of more sustainable resource management practices, it must be seen as an ongoing process within the context of adaptive management. Adaptive management approaches, such as that described here, enable the use of both local and scientific knowledge, and the adoption of a continuous knowledge enhancement process. Providing greater understanding of the system helps the community adapt to change, and can also help to determine what components are most affected by change, in order to target research priorities better. At the same time, participation in the processes of monitoring and adaptive management allows individual land managers to acquire greater technical expertise, building on both collective local knowledge and an associated scientific awareness of their particular physical environment. By achieving specific objectives for the improvement of their resource position through a collective effort, land managers develop greater confidence, and that, in turn, ensures the successful continuation of the whole process.

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