

Adaptive management for CMAs

Effective NRM is more about how we learn than what we know

Natural resource managers have increasing access to sophisticated tools, models and a range of high quality data. Computing power now allows us to employ complex system models capable of grinding through ever larger data sets (often including high resolution spatial data). These amazing developments are giving us important new insights on how we manage our natural resources; but are they all we need? Not by a long shot.

One of the greatest challenges in natural resource management is the least technological — dealing with uncertainty about the effectiveness of our management actions when making decisions. The obvious solution is that we learn as we manage. But how is this done? How can we monitor and evaluate programs and investments to achieve institutional learning and ensure that future management decisions are scientifically and socially defensible?

The way to go

Adaptive management is 'learning by doing', a structured iterative process of decision making with the capacity to gradually reduce uncertainty through system monitoring. It offers transparency and accountability to decision making and resource prioritisation, while providing a formal theoretical foundation for learning and improving management.

Adaptive management is widely held up as the most logical and elegant framework for continuous improvement in natural resource management (and it's a concept that's been around for decades) but the truth is it's rarely implemented. Why is that? Many reasons are cited including a reluctance to invest in long term management experiments, stakeholder risk aversion, failure to identify clear and measurable management goals, inappropriate statistical approaches to inference and learning, and failure

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to monitor the performance of management actions. Many will have heard the statement: “we should be spending that money doing on-ground works rather than on more research”. Maybe all these reasons could be summed up by saying it's not easy and it takes time.

However, when our natural resource base is under growing pressure and significant investments are going into our NRM, maybe it's time to review how we might better apply adaptive management to NRM.

Brendan Wintle (from AEDA) and David Duncan (from Landscape Logic) have recently reviewed the applicability of adaptive management to natural resource management and focussed on how it might be better used in the regional management of native vegetation by catchment management authorities (CMAs). Their review begins with discussion on what adaptive management is and what it is not.

What it's not

Formal approaches to adaptive management integrate information gained from research, monitoring and management to evaluate and improve management practices. Many managers and policy makers confuse adaptive management with ad hoc approaches to continuous improvement that may be better characterised as 'trial and error' management. Trial and error basically entails persisting with the same management option – thought to be the “best practice” at the time – until such time as it's felt to be inadequate. At this point management may be changed in the hope of achieving a better outcome.

While this may be considered 'learning by doing', trial and error management is not underpinned by a formal model (or models) for the system being managed, it does not explicitly recognise uncertainty about the system model in the allocation of management effort, does not involve a plan for learning, and is usually neither replicated nor statistically rigorous. Therefore it's not really adaptive management at all (in a formal or informal sense). Unfortunately, the bulk of management efforts described as 'adaptive management' fit into the category of trial and error management.

Real learning

In contrast, adaptive management explicitly recognises uncertainty about how management actions contribute to management outcomes. And it usually involves concurrent application of competing management options so that learning about the system and the relative efficacy of management may be achieved as management progresses. Learning should be based on a formal evaluation of evidence, preferably supported by statistical inference. Sometimes this is classed as passive adaptive management.

Active adaptive management involves a more aggressive program of learning about the efficacy of management options. It aims to maximise long-term gains through a strategic allocation of resources to management and learning, sometimes at the expense of short term gain.

A discussion of passive and active adaptive management was presented in AEDA information sheets (#3.2 and #3.3; you can download these pages from <http://www.aeda.edu.au/aeda-research-themes>). A detailed overview of the important considerations for effective adaptive management is also presented in Duncan and Wintle (in press).

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In the following discussion we're talking about passive adaptive management (because when it comes to adaptive management in natural resource management there are no examples of active adaptive management) in respect of what it might mean for a Victorian CMA attempting to manage and monitor native vegetation.

There are four basic steps that need to be taken if you're engaging in adaptive management:

Step 1: Identification of management goals, constraints and performance measures

Step 2: Specification of management options

Step 3: Identification of competing system models and model weights

Step 4: Allocation of resources, implementation of management actions and monitoring of management performance.

Step 1: Identification of goals, constraints and performance measures

Objective statements should clearly identify the scope of management, performance measures and constraints that may interfere with achieving goals. Most CMAs in Victoria have been working towards identified medium- to long-range objectives (resource condition targets) that are largely consistent with adaptive management principles. They express quantifiable goals that are to be achieved in a particular time. For example, the North Central CMA aims to "increase native vegetation coverage [from 13%] to 20% of the [CMA] region by 2030". The Goulburn Broken CMA aims to "improve the quality of 90% of existing [2003] native vegetation by 2030".

The current set of objectives and targets could be improved by developing explicit statements about acceptable limits of uncertainty, both in terms of the likely achievement of goals and the ability to precisely measure progress.

Constraints on managers' abilities to achieve native vegetation targets are rarely explicitly recognised. Obvious constraints that inhibit managers' ability to achieve targets include limits to:

- available revegetation budgets
- the number of people who can be engaged to undertake projects
- the amount of land suitable for restoration
- the amount of land that can be converted to native vegetation (while maintaining the economic viability of the farming business).

In order to attempt an optimal management strategy, these constraints need to be identified and, where possible, quantified.

Identifying appropriate performance measures is a critical component of adaptive management. A good performance measure is one that adequately reflects progress towards stated goals. This is far from a trivial task where native

vegetation condition is concerned. We manage native vegetation for multiple benefits including biodiversity conservation and a range of ecosystem services. The link between native vegetation condition and these benefits is not always clear and rarely easy to quantify.

Consequently, CMAs have tended to use system inputs such as the number of hectares fenced off for protection or revegetation activities as performance indicators. These are the activities over which they have most direct control. Unfortunately, there are currently few data or process models to connect these activities with change in the native vegetation or biodiversity resources, which are the target of the activity.

Reporting on the number of hectares fenced, or the number of people participating in vegetation improvement activities would be appropriate if the goal of management is to increase the amount of fencing in the region, or to increase the number of people engaged in native vegetation management (possibly a very important goal). However, such measures provide scant indication about progress towards a stated goal such as increasing the amount or quality of native vegetation cover from 15% to 20% in ten years time. Clearly, the variable of interest here that must be measured is the total area of successful revegetation (requiring a definition of success that should be explicit in the objective statement), or the amount of vegetation condition gain expected from protective actions.

Learning about the relative value of competing management options is central to adaptive management; however, this requires an objective and a performance measure that is directly linked to the management goal. There remain significant challenges in identifying such a measure for goals relating to vegetation condition.

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Adaptive management & meaningful monitoring

Monitoring is central to adaptive management because it provides the quality control and performance evaluation function that is central to continuous improvement. Monitoring the performance of investments in natural resource management is central to the government's credibility as a prudent investor (and the failure to appropriately monitor Australia's NRM investments drew a sharp rebuke from the Australian National Audit Office earlier this year). Monitoring also provides the basis on which to learn about the state of the system and to identify system properties that may be unstable or out of control. However, without the formal link to management goals and performance measures provided by the adaptive management framework, monitoring has a tendency to be inefficient, meaningless and wasteful. Further, monitoring management outcomes only makes sense if there is a genuine commitment and plan for change in response to monitoring results.



Step 2: Specification of management options

Identifying distinct management options is central to adaptive management, but it's a step not often practiced. The full range of potential management options available which address the management objectives should be identified jointly by managers and stakeholders.

The process of assigning credibility to competing models (and consequently evaluating the probability of success under the various management options) happens in later stages of the adaptive management process, hopefully in the presence of data.

The principal vegetation management activities being deployed by CMAs and landholders include:

- remnant protection and enhancement
- revegetation
- pest and weed control
- identification and mapping of high conservation value areas
- creating protection overlays for local planning schemes
- reverse auctions
- community engagement and education
- doing nothing (sometimes the most efficient action).

Step 3: Identification of competing system models and model weights

One of the major technical challenges to the application of adaptive management in vegetation management is the development of system models that can reliably predict the efficacy of competing management options at regional scales. The major impediment to the development of such models is to identify how local level management activities mediate vegetation condition or establishment success.

Victorian CMAs have access to the most advanced statewide datasets relating to the native vegetation resource in Australia. These include the modelled distribution of fine-scaled pre-European and extant Ecological Vegetation Classes (EVCs); and modelled fine-scale vegetation condition for the entire state, which relate the structure and composition of the vegetation to long undisturbed benchmarks for the EVC type. These models are the fundamental inventory that describes the native vegetation assets the CMAs have within their boundaries.

The required system models inform managers about the expected gains in performance measures (eg, area successfully revegetated, or area of vegetation in a minimally acceptable condition) likely to arise from the various competing management options.

Further development of credible native vegetation change models for anticipating resource change at the landscape scale in response to management actions is urgently required. In the absence of scientific data at appropriately broad scales, broad rules of thumb for expected change within existing remnant wooded and nonwooded vegetation sites have been developed for policy purposes. These represent a credible starting point and similar change models have been subsequently, or independently, adopted within some regions.

Without models to predict the relative gains likely to be achieved through competing management options, there is no basis for discerning among options such as spending money on public education and engagement, or providing subsidies for on-ground fencing or planting, when making decisions on resource allocation. This is a major impediment to adaptive management of native vegetation. The uncertainty associated with the effectiveness of competing management options in achieving vegetation management goals highlights the importance of structuring management efforts to facilitate learning and adaptation to new findings.

Step 4: Allocation of resources, implementation and monitoring

Without empirical or process models from which to predict the expected gain in vegetation condition and extent resulting from competing management or investment options, it's difficult to transparently optimise investments.

The prioritisation phase of most native vegetation restoration projects has been an ad hoc procedure based on implicit conceptual models or intuition. This creates three problems. First, because models are not written down and their assumptions not stated, the process of prioritisation lacks transparency.

Second, without writing out the model and assumptions, there is a danger that institutional knowledge will be lost as experienced managers move on and there is no formal basis on which to learn about the plausibility of the model(s) that underpinned the prioritisation.

Finally, intuitive models are often of insufficient precision to distinguish which of the proposed actions are most likely to bring the greatest benefits in terms of vegetation condition, extent or protection. Ongoing development of models describing the ecological benefits arising from competing management actions will provide the foundation for optimising management benefit.

Monitoring the effectiveness of management actions implies that the performance measure (metric) being monitored is directly relevant to the stated objective. Information gained from monitoring may then be fed back into system models to update knowledge and make predictions about the relative benefits of competing management options. In practice, this amounts to re-weighting competing models after each monitoring cycle.

Monitoring change in vegetation quality is a complex and challenging task. As yet there seem to be no strong candidates for short- to medium-time scale monitoring.

Research priorities

There are a great many important research questions regarding native vegetation condition and its responses to management, environment and climate change. Within the adaptive management framework, research priorities should emerge from the questions:

- Which unknowns most impact on our ability to predict the outcomes of our management using our system models?
- What do we need to learn in order to make better predictions and better management decisions about native vegetation condition?

In their review, Duncan and Wintle don't suggest that adaptive management is a silver bullet for all complex natural resource management problems. Even with a perfect adaptive management experiment in place, there would still be considerable uncertainty as to the effectiveness of some of our actions to improve complex natural resource assets such as native vegetation condition. However, coherent management behaviour in the face of uncertainty is highly desirable, but it's not easy to achieve without a formal decision framework such as adaptive management. And what we're actually doing at the moment – management via trial and error – is simply not up to the task.

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This information sheet is based on

Duncan D and Wintle B (in press), "Towards Adaptive Management of Native Vegetation in Regional Landscapes", in C Pettit, W Cartwright, I Bishop, K Lowell, D Pullar, D Duncan (eds) *Landscape Analysis and Visualisation: Spatial Models for Natural Resource Management and Planning*, Springer Verlag, Berlin.