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The Bowral Checklist

A framework for ecological management of landscapes

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The Bowral Checklist: A framework for ecological management of landscapes. David Salt and David Lindenmayer

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The Bowral Checklist

Managing landscapes for multiple uses such as conservation and commodity production has always been challenging. While several decades of research has produced a large base of scientific literature, there is little consensus on a framework or checklist of issues for underpinning landscape conservation.

A group of leading landscape ecologists and conservation biologists came together in Bowral in 2006 to discuss whether it was possible to create such a checklist. They identified 12 important issues that need to be considered in developing approaches to landscape conservation, a set referred to as the Bowral Checklist.

Issues appearing in the framework include recognising the importance of landscape mosaics (including the integration of terrestrial and aquatic areas), recognising interactions between vegetation cover and vegetation configuration, using an appropriate landscape conceptual model, maintaining the capacity to recover from disturbance, and managing landscapes in an adaptive framework. These considerations are influenced by landscape context and management goals and do not, therefore, translate directly into on-the-ground management guidelines. Rather, they should be used as a framework by researchers and resource managers when developing guidelines for specific cases.

This technical note presents information on the Bowral Checklist. It is based on Lindenmayer, D.B., Hobbs, R.J., Montague-Drake, R. et al. 2008, 'A Checklist for Ecological Management of Landscapes for Conservation', *Ecology Letters*, vol. 11, pp. 78–91.

Photo above Stuart Pearson.

All managers have some expertise

If you have some responsibility for managing an Australian landscape for conservation it's likely you know something about that landscape and a bit about conservation. You're probably aware of several studies on different native animals or plants or invasive organisms, and you may well have some experience of several aspects of local landscape processes. This knowledge would provide you with valuable insights that might inform any management plan you are writing or implementing. These insights might be thought of as pieces in a larger ecological jigsaw puzzle. The more pieces you possess, the better your chances of effectively managing the landscape.

Of course, no-one has all the pieces, not even the most experienced ecologist or land manager. However, as a manager, you need to have a good idea of how your plan addresses the bigger picture. Are there any glaring gaps in your plan? Are there any areas of current ecological knowledge that may have been ignored? This raises a big question: where would you turn for some generalised framework for ecological management?

Until recently, such a framework hasn't existed. There are many models and approaches available for interpreting aspects of landscape patterns and processes but nothing that might serve as an overarching framework against which you could consider any plan of management for gaps. Indeed, the lack of such a framework is something that has been of considerable concern to many of the world's most experienced ecologists and land managers.

The need for a general framework is now more urgent than ever because much ecological knowledge fails to be adopted on the ground. And this is a time in which the modification of our landscapes is accelerating (and there is a growing threat from climate change).

From ecological perspectives to a checklist of key issues

The fields of landscape ecology, conservation biology and restoration ecology have been around for decades. They are responsible for a large and rapidly expanding published literature. They are truly applied disciplines in that they attempt to generate insights that will promote better management of natural resources and biodiversity. However, most investigations within these disciplines focus on specific species or specific landscapes or specific case studies.

Are there general insights that can be gleaned from the body of work to date? What can ecologists say that is both useful and critical for guiding the management of any landscape for conservation, and beyond that the ecological design of landscapes to achieve conservation goals? These were the overarching questions posed to a gathering of leading researchers in landscape ecology and conservation biology in Bowral, New South Wales, in March 2006 (see the box 'The Bowral Brainstorm').

Participants were asked to appraise a given topic in landscape research and identify 5–10 general insights or issues emerging from that topic. The Bowral meeting resulted in an analysis relating to six broad themes in landscape ecology:

- landscape classification;
- habitat amount, amount of land cover, patch sizes and mosaics;
- structure and condition;
- connectivity;
- the significance of edges; and
- disturbance, resilience and recovery.

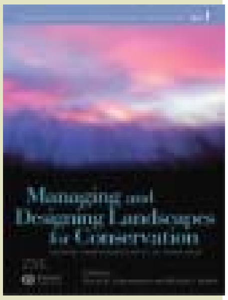
The analysis raised points of agreement and important unresolved issues associated with each of these themes, and then generated 12 important issues aimed at fostering the development of practical goals for landscape conservation (the Bowral Checklist).

Photo Stuart Pearson.

The Bowral Brainstorm

Leading and emerging researchers in landscape ecology and conservation biology gathered in Bowral, southern New South Wales, in March 2006 to discuss whether it was possible to create a general framework to guide the management of landscapes for conservation. Participants were asked to appraise a given topic in landscape research and identify 5–10 general insights or key issues emerging from that topic. The topics were clustered into 10 major themes with researchers asked to produce 4000 word essays on each topic.

Authors came from a diverse range of backgrounds ('old farts' and 'young Turks'), different disciplines (traditional fields mixed with the emerging and innovative) and different places (from all over Australia plus input from around the world).



The result of their discussions was a 600-page textbook titled *Managing and Designing Landscapes for Conservation: Moving from perspectives to principles*. The book provides a distillation of current thinking in landscape management and conservation. It offers a blend of theoretical and practical information that is illustrated with case studies drawn from across the globe.

The workshop was partially funded by Land & Water Australia and the Australian Research Council.

If you'd like a more detailed read on the discussions that led to the creation of this checklist, see Lindenmayer, D.B. and Hobbs, R.J. (editors), 2007, *Managing and Designing Landscapes for Conservation: Moving from perspectives to principles*, Blackwell Publishing.

The Bowral Checklist

Setting goals

1. Develop long-term shared visions and quantifiable objectives.

Spatial issues

2. Manage the entire mosaic, not just the pieces.
3. Consider both the amount and configuration of habitat and particular land cover types.
4. Identify disproportionately important species, processes and landscape elements.
5. Integrate aquatic and terrestrial environments.
6. Use a landscape classification and conceptual models appropriate to objectives.

Temporal issues

7. Maintain the capability of landscapes to recover from disturbances.
8. Manage for change.
9. Time lags between events and consequences are inevitable.

Management approaches

10. Manage in an experimental framework.
11. Manage both species and ecosystems.
12. Manage at multiple scales.

While some of these considerations may seem trite to some researchers, there is evidence they are often overlooked by many other researchers as well as managers in developing landscape plans (and, hence, much existing knowledge is not used).

It is important to note that these considerations cannot be transferred uncritically and directly into on-the-ground action. Rather, they provide a set of key issues to be considered by agencies and resource managers when developing practical plans and guidelines.

The Checklist

The Bowral meeting identified a number of important issues aimed at fostering the development of practical goals for landscape conservation. Twelve are discussed in this report. These considerations are not highly prescriptive. Rather, they form a checklist of factors to be considered by people managing landscapes for conservation. It may then be appropriate for them to be formulated as a set of hypotheses more specific to a particular set of circumstances.

Setting goals

1. Develop long-term shared visions and quantifiable objectives

Much conservation is undertaken without consideration of goals or whether goals are achievable given ecological, social and economic constraints. Ecologists and resource managers have been poor at problem definition and objective setting. Clear objectives need to be derived from a broad vision of what people want from landscapes in the future: What should they look like? What services do we want from them?

But the objectives need to be more than just clear, they also need to be defined in such a way that it's possible to record what has been achieved in terms of attempting to meet them. It's not enough to say the objective is 'to improve conservation'. What's needed is a quantifiable goal that is to be achieved in a particular time. For a catchment management authority, for example, this might be along the lines of: 'increase native vegetation cover from 13% to 20% in the region being managed by 2030'.

As soon as you begin to create measurable goals the difficulty in this step becomes apparent because not all goals are equal. For example, few if any areas of land or water have a single value.

Photo David Salt.

Photo Jim Donaldson.

Even when conservation is the primary activity, different kinds of plans and actions will result from different kinds of objectives. Different conservation objectives, for example, might be the maintenance of species diversity, the preservation of particular threatened species, the maintenance of ecological processes (such as plant regeneration), and the maintenance of ecosystem services (such as water purification).

Different objectives also will arise depending on considerations such as land tenure or anticipated land use. Often there is conflict between different objectives (e.g., maximising timber production versus maintaining biodiversity). Sometimes there will be no single 'best' plan for a landscape. In this case multiple scenarios need to be assessed.

When considering different conservation objectives it's important to assess the different benefit-to-cost outcomes associated with objectives (e.g., is it a good use of resources to focus only on endangered species management?). A variety of different prioritisation tools and techniques exist to assess the trade-offs. While trade-offs are not always easy to determine, we need to identify the best conservation options to achieve a particular goal and minimise the risk of failure.

It needs to be acknowledged up front that there will always be uncertainty in setting goals and making plans. Given this we need to learn as we manage — adaptively manage — and be constantly reviewing outcomes. Monitoring is central to adaptive management because it provides the quality control and performance evaluation that is central to continual improvement.

Spatial issues

2. Manage the entire mosaic, not just the pieces

Managing at the scale of the patch is still the norm, but this approach ignores flows of species, water and nutrients as well as interactions among elements of a landscape mosaic of patches. A single patch can be subjected to state-of-the-art conservation, but that management can fail if the surrounding landscape continues to degrade, with adverse impacts on the patch.

Patches need to be assessed and managed within the context of landscape mosaics and the broader landscape. A research challenge is to design robust surveys that generate high quality data on species inhabiting mosaics, emphasising information on demographic performance in different parts of the mosaic.

Mosaics change over time. Understanding their dynamics is an important challenge. What was the nature of the mosaic that pre-existed the one we're dealing with today. For example, if a grazing landscape is converted to a tree plantation, what becomes of the remnant vegetation that was found in the grazing landscape? Do we need to modify our management of the remnants now that they are surrounded by a growing monoculture of trees where once open pastures existed?

Photo Nadeem Samnakay.

3. Consider both the amount and configuration of habitat and particular land cover types

Related to 'Managing the entire mosaic', the amount of habitat remaining in an area is often the most important factor determining persistence of different species in many (but certainly not all) landscapes. It also can influence ecological processes such as erosion rates and nutrient losses.

Habitat configuration (i.e., the proximity of one patch to other patches) is often less important than habitat quantity until levels become low (e.g., below 10–30%). It's believed that threshold effects and regime shifts are also more likely when the amount of habitat becomes very low.

Better methods for testing for threshold and other kinds of responses, both for ecological processes and individual species would assist conservation management. In Australian landscapes that have not had a prolonged history of European modification (e.g., the northern savannas), it will be critical to consider both avoiding low levels of habitat and identifying 'safe' levels for management.

In landscapes that have had a long history of extensive European agricultural management (such as the grazing lands in south east Australia), it may be impossible to avoid going under low levels of original native land cover. What biodiversity remains is probably best managed by caring for the remaining remnant vegetation and limiting further agricultural intensification.

4. Identify disproportionately important species, processes and landscape elements

Some landscape elements may be disproportionately important because of their provision of key resources such as water or nutrients or for their spatial context in enhancing connectivity and gene flow. Water courses with intact native vegetation, for example, has been shown to be critical to the movement of native bush rats from remnant patch to patch through plantations.

There may also be species of particular concern, either because of their relative scarcity due to landscape change or because of their disproportionate impact on an ecosystem (e.g., 'ecosystem engineers' and 'keystone' species). The importance of these entities is often only recognised when problems arise. For example, if bats are lost from tropical farming landscapes, native fruit trees scattered throughout these areas may no longer regenerate. The loss of these trees may, in turn, reduce gene flow between tree populations in nearby rainforest remnants, with potentially far-reaching consequences for the long-term viability of the flora and fauna in these remnants.

Better approaches to identifying key landscape elements and species would assist their proactive management.

Photo Nadeem Samnakay.

5. Integrate aquatic and terrestrial environments

Terrestrial and aquatic elements of landscapes are closely interlinked, although management practices and institutional arrangements rarely reflect this interconnectedness. Managers need to be better aware of relationships between, for example, patch and landscape-level land management activities such as restoration and plantation forestry and attributes of aquatic ecosystems such as streamflow.

Catchment- or watershed-level management will usually be essential to better integrate the conservation of aquatic and terrestrial environments.

6. Use a landscape classification and conceptual models appropriate to objectives

The selection of a landscape model for addressing a particular objective or problem needs much deeper thought than is widely recognised. To begin with we need to acknowledge that there is no single 'best' approach to landscape classification. How humans perceive the landscape may not reflect how it is perceived by other species, and this is relevant to how we classify, map and conserve landscapes.

For example, while the patch-matrix model of landscapes (which essentially portrays the landscape as 'islands' of remnant vegetation surrounded by an inhospitable 'ocean' of cleared land which is the matrix) serves a useful purpose in showing how species might respond to landscape change, for many taxa this model is too simplistic. The patch-matrix model assigns landscape elements as either habitat or non-habitat. But this is problematic when the surrounding landscape has some value as habitat for biota.

For example, areas of scattered paddock trees are often not thought of as habitat. However, they can be valuable areas for reptiles and supplement populations found in larger remnants.

Other models used in landscape classification may be more appropriate to guide conservation such as when improving the habitat value of surrounding areas for a particular species is an important goal. It's important to articulate the goals and problems being addressed when deciding on the underlying conceptual model being applied.

Photo Roger Charlton.

Temporal issues

7. Maintain the capability of landscapes to recover from disturbances

It is important to maintain the potential for a landscape to recover from disturbance. This includes maintaining processes and flows and the ability of the biota in a landscape to cope with extreme events (e.g., floods and droughts). A better understanding of how ecosystems recover after natural and human disturbances would help guide management actions, for example, maintaining the integrity of key areas that act as refugia for certain species.

Managers need to better recognise that natural disturbances can be valuable for ecosystems and biodiversity. They should not limit their focus to single disturbance events (e.g., single wildfires) but rather consider disturbance regimes (the frequency and intensity of fires over time).

And rather than allowing events to drive management responses, it may be better to anticipate extreme events and plan contingencies before they occur. For example, estimates of sustained timber yields in forest planning should account for the impacts of major natural disturbances such as wildfires and windstorms. This might be made more tractable by expanding the units for management beyond individual patches to mosaics, entire landscapes and broader regions.

Although increased recognition of the ecological roles of natural disturbances is important, researchers and managers also need to be aware of potential limitations of approaches based on using natural disturbances to guide human disturbances. For example: (i) human disturbance can never mimic natural disturbance regimes exactly, (ii) some very complex processes are extremely difficult to emulate and (iii) some management objectives will remain unachieved. For example, the process of soil formation that develops from trees being uprooted by windstorms is not one that human interventions can readily mimic.

Given these limitations, an objective should be to quantify differences between natural and human disturbance regimes and, in turn, to find ways of creating human disturbance regimes that are more similar (rather than identical) to naturally occurring ones. In addition, highly targeted actions (that go beyond following natural disturbance regimes) might be needed to meet particular management objectives such as the restoration of particular processes or the creation of specialised habitat attributes for an individual threatened species. For example, some species have become extinct in some ecosystems and the only way to restore them is by capture, breeding and translocation programs.

Top row of photos Michael Douglas. Below Roger Charlton.

Photo Alison Pouliot.

8. Manage for change

Although conservation often aims at keeping things steady and assumes an equilibrium state for natural systems, landscapes are dynamic (and may become more so with future climate variability). Changes can be non-linear and sometimes related to thresholds. In other words, push a landscape beyond a certain point (e.g., clear too much native vegetation or change the natural frequency of fires) and it often begins behaving in a completely different way and moves towards a new equilibrium.

A deliberate effort to identify thresholds of potential concern should be part of any landscape conservation strategy. 'Novel' dynamics initiated by human intervention are often superimposed on natural dynamics in response to disturbance at varying scales. Failure to acknowledge the dynamic nature of systems will inevitably result in unexpected change and unachieved conservation goals.

Given their dynamic nature and the growing uncertainty connected with climate change, we should plan to accommodate successional dynamics (i.e., ecosystems moving through successional stages and behaving in different ways in each stage), spatial and temporal mosaics, colonisation and extinction processes, and likely shifts in species distributions.

Developing a capacity to effectively manage a dynamic system is complicated by the institutional tendency to ignore potential problems until they become critical, and only then managing the situation as a crisis (consider the management of many of our most important river systems). There is therefore a need to develop capacity for preventative management.

9. Time lags between events and consequences are inevitable

This applies to attempts to restore damaged systems as well as to the adverse effects of human activities. For instance, the impacts of landscape restoration may not be seen in terms of biotic changes for many decades if the vegetation grows slowly, and the impacts of human activities like pesticide use may take a long time to become evident. Approaches for better predicting time lags, and anticipating circumstances where they might be important, would assist conservation management.

We need to identify methods for reducing time lags (e.g., creative thinning of replanted forests to promote structural diversity of vegetation cover). Managers need to better understand that inappropriate actions now may take a prolonged period to manifest (for example extinction debts refers to the inevitable loss of species down the track through the loss of critical habitat or as populations becoming unviable) and / or prolonged periods to reverse (e.g., recruitment of large slow growing trees and the tree hollows they provide).

Management approaches

10. Manage in an experimental framework

Because of contingency, lack of knowledge of biotic responses, and complex system dynamics, there is always significant uncertainty associated with landscape management. Hence, it is crucial not to do the same thing everywhere so that we can limit the risk of making the same mistake everywhere. If we treat the variety of management options as adaptive management experiments we can continuously improve our understanding of how ecosystems function and respond with more effective management over time.

This involves careful consideration of experimental design and the implementation of monitoring programs that will effectively guide improved management. Without the formal link to management goals and performance measures provided by the adaptive management framework, monitoring has a tendency to be inefficient and wasteful. Further, monitoring management outcomes only makes sense if there is a genuine commitment and plan for change in response to monitoring results.

True adaptive management landscape experiments are rare, and they need to be implemented far more widely.

11. Manage both species and ecosystems

Single-species and ecosystem conservation are not competing approaches. Rather, a range of conservation strategies will nearly always be required: some focused on individual species, others on suites of species and yet others on entire landscapes or ecosystems; and there will be inter-linkages among all of these.

12. Manage at multiple scales

A single strategy adopted at a single spatial scale will meet only a limited number of goals. For example, it will provide suitable habitat for only a limited number of taxa. Multiple management scales are needed because landscapes operate at multiple ecological scales, not only for different ecological processes and different species, but also for the same species. For example, in forests it is now well accepted that management must be focussed on individual stands of trees, on patches and on landscapes.

Photo Roger Charlton.

Where to from here?

The objective of the Bowral workshop was to bring together a variety of perspectives on landscape ecology, conservation biology and restoration ecology and to mould them into a set of broad considerations that have some generality. The hope is that the checklist will provide a starting point for further discussion and development.

For these emerging guidelines to be implemented, they need to be considered in context of the local landscape, its biota and the goals and objectives of conservation. Interpreting them in the context of local examples is a valuable step in making them more accessible and relevant to managers, and this can be achieved best by conducting the relevant research in landscapes at a variety of appropriate spatial scales.

If we focus subsequent scientific endeavours on actual landscape conservation challenges, we may be able to make real progress in developing sound, scientifically based approaches to landscape management in general. This, in turn, can contribute positively to meeting the challenge of biodiversity conservation and ecologically sustainable resource use in the face of rapidly changing global, regional and local environments.

Photo courtesy of Greening Australia Capital Region.

Knowledge gaps

Creating the checklist served to highlight four areas for future work.

1. **Interrelationships**: How can we include the complexity of gradients and other phenomena in landscape models and move beyond the traditional approach of binary, patch-based models (i.e., models of landscapes that simply suggest 'islands' of habitat surrounded by 'oceans' of non habitat)?
2. **Connectivity** is a primary process influencing ecosystem function and the distribution, abundance and persistence of all biota. Yet the mantra of 'the more connectivity the better' is too simple as there are circumstances where this would have negative consequences. For example, connectivity may promote the spread of invasive taxa. We need better approaches to determine when, where and why more connectivity is desirable and when it is not.
3. **Large-scale disturbances** such as fires and floods can be important drivers of ecosystem and landscape processes. We need to better understand the impacts of these events because they can produce ecological surprises. What's more, some kinds of major disturbances (e.g., heatwaves, droughts and fires) will increase in frequency, intensity or both as a consequence of climate change.
4. **Implementation**: How can the findings from the enormous body of knowledge from landscape ecology, conservation biology and restoration ecology be better translated into on-the-ground management of landscapes? Methods such as meta-analysis and systematic review (where the results of many studies are pooled) are valuable, but much research has little bearing on practice. The knowledge transfer process itself requires deeper exploration.

If more effective knowledge transfer can occur, it will be important to increase the number of scientifically based landscape planning and management examples that encompass true adaptive management experiments. This will ensure that opportunities are taken to gain new knowledge about landscape management.

How does your management plan measure up against the checklist?

1. Does it develop long-term shared visions with quantifiable objectives? Have you done any form of cost benefit analysis on what it might take to achieve different objectives?
2. Does it consider the entire landscape mosaic (not just the pieces)?
3. Does it look at the amount and configuration of habitat?
4. Does it identify the disproportionately important landscape elements (e.g., 'keystone' species and critical ecosystem processes)?
5. Does it integrate aquatic and terrestrial environments? Does it work at a catchment scale?
6. Does it use landscape classifications and conceptual models appropriate to your objectives (or does it break the landscape up into simple habitat versus non habitat categories)?
7. Does it assist the landscape to recover from disturbances? Is it understood how the landscape recovers from disturbances?
8. Does it take into account change? Does it acknowledge the dynamic nature of your landscape?
9. Does it account for time lags between events and their consequences?
10. Does it foster learning and incorporate an experimental (adaptive management) framework? Does it have appropriate provision for monitoring?
11. Does it manage both species and ecosystems?
12. Does it manage at multiple scales?

Some of these questions interact and overlap with other questions. Some of them may not be relevant to your particular plan (for example, your plan may not encompass both aquatic and terrestrial environments). However, if you are unable to respond to one of these areas because you are unaware of how your plan relates to the current state of knowledge then there may be scope for improvement.

Principles and policy

Measuring the policy and management impact of a scientific paper is always difficult to demonstrate, but sometimes flags will go up demonstrating that the science is being noticed in policy circles. Just such a flag popped up with the publication of the Bowral Checklist in the journal *Ecology Letters* in 2008.

Within weeks of the paper's publication a summary of its findings appeared in the Science for Environment Policy news alert, the European Union's environmental news service for policy makers — distributed to over 6000 subscribers.

To visit the EU policy service go to:
http://ec.europa.eu/environment/integration/research/newsalert/themes_en.html

To go directly to their checklist summary go to:
http://ec.europa.eu/environment/integration/research/newsalert/pdf/97na4.pdf

Photo Bruce Thomson.

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