The business of biodiversity

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DOES CONSERVATION BIOLOGY HELP US MAKE DECISIONS?

Conservation biology is a branch of ecology that has blossomed over the past two decades. The proliferation of conservation journals is evidence of this fact. Wildlife and ecosystem managers are looking to this burgeoning discipline for help in solving their problems. Many of the theory papers in conservation journals purport to be useful to managers in helping them make decisions. Many of us who publish in these journals certainly hope that our work will make a real difference in action, policy or legislation. Why then do so few of the papers appear to have any short-term impact on solving real conservation problems — is it a matter of time or a matter of focus? Are we merely paying lip service to solving real problems while selling pure ecology under the veneer of application?

Conservation biology is a branch of applied ecology. Any applied discipline should deliver research that helps us to make real decisions. To build a theory of conservation biology we need to combine ecological theory with decision theory and facilitate that application; we need to put our tools and theories within a management framework. This means becoming more like engineers than physicists; the former solve problems using the theories of the latter. In this essay we discuss the next important step for the field of applied conservation — the step of putting ecology in a decision theory and management framework — creating the business of biodiversity.

In Australia the time for a business of biodiversity has never been more appropriate. Consider, for example, the Natural Heritage Trust — a major supplier of funds for on-ground biodiversity management. The economic rationale behind the NHT is very transparent. The implied ethic is that one public asset — a telephone company called Telstra — can be converted into another public asset — soil, water or biodiversity. It is a very business-like approach to managing our natural wealth.

WHAT IS DECISION THEORY?

In its broadest sense decision theory is simply the framework within which we make management decisions. It is as much the process of decision theory, as the precise mathematical or social tools used to make the decision, which is important. Sound decision theory is made up of the following steps:

- A clear statement of the objective — for example minimizing the extinction probability of a threatened species or maximizing the species richness of a reserve.
- A list of what management options are feasible, including some description of their costs — for example captive breeding, habitat restoration, closing a road.
- A description of the dynamics of the system, including definitions of state variables and constraints on those variable. Often this amounts to a population model for a single species problem, however, for ecosystem management it will at least involve a description of vegetation dynamics. The state dynamics may explicitly include a budget with the obvious state variable, money.
- Solving the problem. Once the problem is well defined we can use a wide variety of quantitative and qualitative processes for making a decision, or advising decision makers. These range from formal optimization methods to more qualitative methods like multi-criteria analysis.

WHAT USEFUL THEORY DO WE HAVE FOR APPLIED CONSERVATION?

Wildlife management and conservation journals contain a lot of interesting ecology. Let us consider a few of the topical issues in these journals and see if they help us make decisions.

Papers concerning patch shape, corridors or edge effects are frequently published. These are landscape level issues that are intended to help us in habitat restoration (or retention) decisions. A common question is — are corridors useful? The answer to this question is usually yes, but the conclusion is trite. Surely the more useful question is: given a constraint on the amount of revegetation we can do, should we build a habitat corridor or expand an existing patch of habitat? Alternatively, if we are restricted to making a corridor, where should the corridor be to maximize its benefits? These questions reflect real constraints and tradeoffs in the face of which we have to make real decisions. The issue is not simply whether something is good, but whether it is better than the alternatives.

Metapopulation theory is often touted as one of the shiny new theories for applied conservation, yet rarely has it been used for making decisions. The basic metapopulation paradigm has given us some general insights for species that display metapopulation-like dynamics (Hanski and Gilpin 1997). The theory has honed our intuition, but if we are to translate the theory into action, the conclusions are unhelpful. A species is more likely to survive if: it has more patches to occupy, it does occupy more patches, local extinction rates are low or colonization rates are high. The theory does not tell us which management options are best to achieve these goals. It is only recently that decision theory approaches have been applied to minimizing the extinction probability of spatially structured populations (Lubow 1996; Possingham 1996). Lubow (1996) considered the problem of translocating animals backwards and forwards between two populations to minimize extinction probability; Possingham (1996) addressed the problem of when translocations in to empty habitat patches is more effective than creating new habitat patches to achieve the same goal.

Most issues of conservation journals contain a Population Viability Analysis or related form of population model. Many of these papers present the model and then find the extinction probability of the target population without providing the manager with alternative management options. Even if different management options are tested — the relative economic costs of those options are rarely considered (Lindenmayer and Possingham 1996; Shea *et al.* 1998).

Fire management is one of the most contentious conservation management issues in Australia, yet we have rarely used decision theory to help us make fire related decisions. There are numerous opinions expressed, both in the scientific literature and elsewhere, about whether there are too many fires, too few fires, fires that are too intense and so on. Much of the debate leads nowhere because the first step of decision theory has not been made, defining the objective. Many of the divergent opinions about fire boil down to differences of opinions about objectives. Once the objective, constraints and state dynamics are defined, for example to maximize the vegetation diversity given a budget for fire management, we can use tools like stochastic dynamic programming to make the best decision given the current state of the park (Richards *et al.* 1999, Fig. 1). Figure 1 delivers a park manager a fire management policy that depends on the current proportions of the park in different successional states and a particular objective and set of parameters. The policy will change from year to year as the state of the park changes through the processes of succession and wildfire.

We have presented a somewhat cynical, and probably overstated, view of how far conservation biology has progressed in delivering a real theory of applied ecology. On an optimistic note there are now several workers that have begun to use decision theory to help conservation (Maguire *et al.* 1987; Ralls and Starfield 1995; Milner-Gulland 1997; Possingham and Tuck 1998). Often these are specific applications to specific problems. Eventually, as we solve more problems, we hope to be able to develop some broad generalizations, or robust rules of thumb, that managers can quickly apply to their specific circumstances.

THE BUSINESS OF BIODIVERSITY

If we feel uncomfortable with the notion of taking a business-like approach to conservation, then consider the following parting analogy. Imagine you are the director of one branch of a large business. You have been given a multi-million dollar annual budget to create a biodiversity asset. If at the end of the year you are unable to clearly state what you have achieved (because of lack of monitoring), and you have no clear framework for allocating resources to maximize biodiversity, you will probably be in search of a new job. Many of us are in the field of conservation biology to "save the planet". While this is laudable we would be naïve to believe that our management actions do not impinge on the values of other sectors of society and are free from the economic constraints that apply to all other human endeavours.

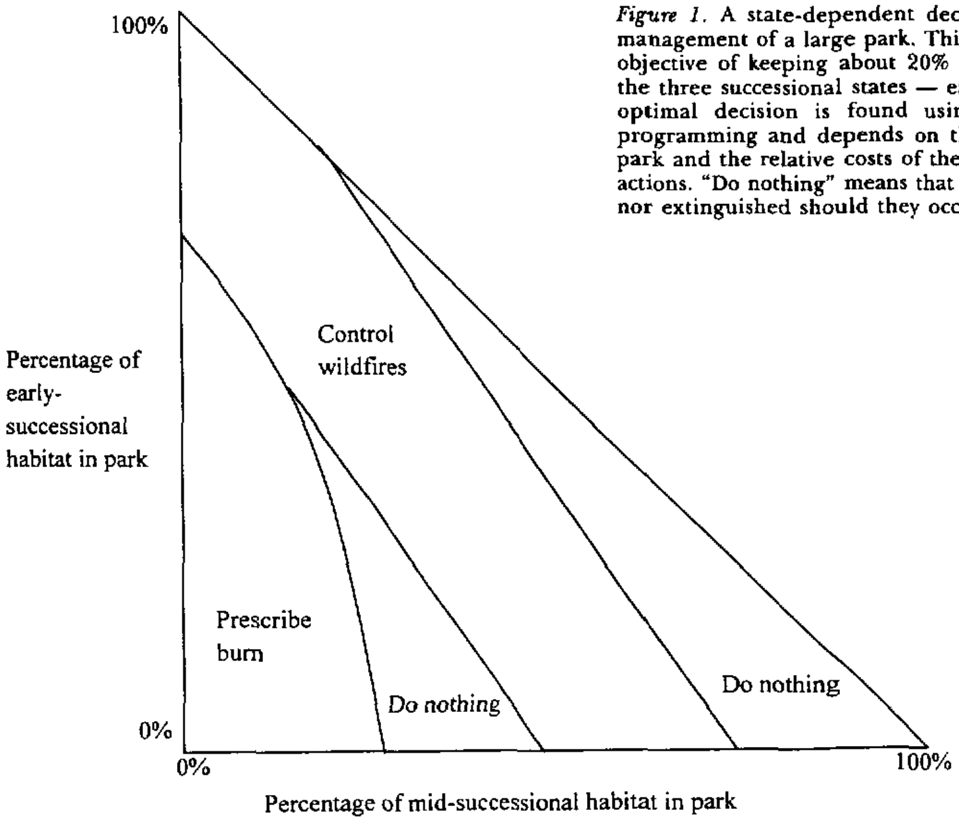

Figure 1. A state-dependent decision diagram for fire management of a large park. This result is based on the objective of keeping about 20% of the park in each of the three successional states — early, mid and late. The optimal decision is found using stochastic dynamic programming and depends on the current state of the park and the relative costs of the different management actions. "Do nothing" means that fires are neither started nor extinguished should they occur by any means.

Conservation biology needs to incorporate the tools of decision making that take into account constraints and tradeoffs to deliver the best possible long-term outcome. We need to take a more business-like approach to providing management prescriptions for conservation. We need to prove to the community at large that we can deliver ecosystem management and conservation solutions that are effective **and** efficient.

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