Adaptive management

Live and learn (and plan!)

By Cindy Hauser

'Adaptive management' is one of the buzz terms of the times. It's a phrase bandied about in the academic literature and, increasingly, you'll see it in policy statements of wildlife management agencies, NGOs and government departments at all levels. However, while most people using the term have a good general idea what it means – it's all about learning by doing – fewer people appreciate the different ways you can approach adaptive management.

Most users of the phrase would agree that adaptive management involves actively managing an ecosystem and adapting our procedures over time to learn from our mistakes. However it's less clear how we should plan our management procedures in the first place. If we don't understand everything about our ecosystem and the way it reacts to management, what's the best way to step into the unknown?

A brief history of adaptive management

The term 'adaptive management' was first coined by the ecologists C.S. Holling and Carl Walters in the late 1970s (Holling 1978, Walters 1986). They developed a procedure for managing ecosystems where there is uncertainty about how the system works, which creates uncertainty about how best to manage the ecosystem. Adaptive management involves:

• clear **specification of the management objective**. How will we recognise if management is successful or unsuccessful?

The success rates of different revegetation strategies are unknown. How would you adaptively manage this situation?

• **articulating all the different ways** the ecosystem might work (hypotheses), **and weighting or ranking them** according to how plausible they are;

• **monitoring how the system reacts** to management. This gives us feedback on which hypotheses stand up to scrutiny

• **updating our understanding of how the system might work** (adjusting our hypotheses) and adapting our management accordingly.

This approach is more rigorous than trial and error, and has a lot in common with scientific experimental design. However, it recognises that ecosystem managers do not have the luxury of extensively replicating different treatments over time and space before making a decision. Instead, they must manage (treat) a unique system without delay and learn as they go. They need to adopt a strategy that has the highest probability of meeting their objectives, averaged over all possible present and future scenarios (hypotheses).

Examples of adaptive management

Formal adaptive management involves translating your hypotheses into mathematical models and then deriving your optimal strategy mathematically. This approach has been primarily practised in fisheries and in the harvest of waterfowl (eg, Walters 1981, Williams 1996).

Example 1: A typical problem might involve a fishery that has been maintained at a very low stock size for many years. The relationship between population density and reproduction and recruitment is uncertain, but it's possible that the fishery could yield higher catches (and hence larger profits) if fish stocks were permitted to grow to a larger size. Should fishing be limited in the short term to test whether larger catches are possible later? What's the most profitable strategy in the long run?(See Walters 1981)

Actually, adaptive management is relevant to many areas beyond commercial harvesting. Consider the following examples.

Example 2: A noxious weed has been introduced into a new landscape. It will spread locally from the initial incursion, as well as occasionally dispersing over long distances. Given limited time and funding, should a manager focus on attacking the core population or new populations or some combination of both? The optimal strategy depends on the probability and range of long-distance dispersal, which is not well understood. (See Shea et al 2002)

Example 3: A manager has been given funding to revegetate an area, and can use it for high or low-density planting. Although the success rates of each approach are uncertain, it's expected that high-density planting yields a higher probability of success. However, high-density planting also costs more per hectare. To discover the most cost-effective strategy, the manager could plant several hectares at different densities and learn from the successes and failures that result. How many treatments of each density should he plant, and for how long should he experiment before shifting entirely to his preferred density? (See McCarthy and Possingham 2007).

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Example 4: A conservation agency has established a captive population of a threatened species, and their goal is to establish viable wild populations. There are several potential sites for re-introduction of the species but it is unknown whether a population can become self-sustaining at each site. At which sites should the agency re-introduce individuals, and how many? How will they recognise that a population is viable, or choose to abandon a site? (This is the focus of current research I'm involved in with AEDA members Tracy Rout and Hugh Possingham.)

A calculated risk

An adaptive manager needs to balance learning with meeting the objectives of their project. Learning should ultimately improve understanding so that managers can meet their objectives more efficiently. However, it can also be seen in the examples I have cited that for fast learning you might compromise your management objectives.

In example 1, the learning of the strength of density-dependence in fish populations will require the sacrifice of fishing catches in the short term, and may or may not yield larger profits in the long term. In example 2, the strategy might involve uncontrolled 'baseline' weed populations, and these carry a risk of further weed dispersal and damage to the environment. In example 3, some areas will inevitably be planted at an inefficient density (causing some vegetation failures) as the most cost-efficient density is learned. Finally, in example 4, learning whether or not a site is viable with a high degree of confidence will involve sacrificing individuals at unviable sites and allocating superfluous individuals to viable sites.

Reintroducing a threatened species to the wild is a difficult and costly task fraught with uncertainty. How do you manage the unknowns?

A passive adaptive manager may not take these risks, as such. They will assess the likely outcome of each strategy, averaged over all possible scenarios (hypotheses), and implement the one that's most likely to achieve their objectives based on their current knowledge. They will learn as they continue to manage, but they do not consider the potential benefits of sacrificing their objectives initially to speed up the learning process.

An active adaptive manager does anticipate the knowledge to be gained from experimenting. They assess the likely outcome of and learning from each strategy, choosing the one that's most likely to achieve their objectives overall. Experimental strategies are only chosen if they're expected to improve future management above and beyond the sacrifices made.

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Even though passive adaptive managers are not 'risk-takers', assessing all the evidence on balance may lead to a management plan that is different from the status quo. They need to push past institutional inertia and respond to evidence in a balanced way as it emerges. An active adaptive manager will take only calculated risks, those that are expected to generate useful information that can be incorporated into future management effectively. While this may involve wild departures from current practice, it may simply consist of a different combination of current practices.

It has generally been assumed that an active adaptive manager will be as or more daring than a passive adaptive manager. However a new article (to be presented in an upcoming AEDA info sheet) demonstrates that this depends crucially on the time frame of management, as well as the way in which the manager discounts the future.

References

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Passive versus active

Thorough adaptive management involves not just learning from mistakes, but a careful process of examining the possible states of nature and planning for them. A manager can proceed by choosing the best strategy on the balance of current evidence (passive adaptive management), or consider the risks and potential benefits of experimenting to accelerate learning (active adaptive management).

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