Planning adaptive management

Why there's no time like the present.

By Cindy Hauser

Two new papers, co-authored by AEDA members, demonstrate that the need for experimental management depends crucially on a manager's tendency to discount future performance, and their time frame of management.

Discounting

Discounting has a long history in the economic literature, and has found its way to ecology via fisheries and wildlife harvest management. The premise is that achieving my goals this year is more important to me than achieving my goals in some future year. For example, a fisherman taking a 100 tonne catch this year can sell those fish and invest his profits at some interest rate. He expects that this investment will be worth more in 10 years time than the 100 tonnes of fish he'll catch and sell in that 10th year.

So, achieving our goals in the future isn't as valuable as achieving the same goals this year. It follows that sacrificing our goals now for experimentation and learning may not be so worthwhile if it's only going to improve our achievements a long way into the future. Thus, discounting diminishes the value of experimentation, and experimentation is unlikely to be a part of the optimal active adaptive management plan.

Given the economic rationale described above, most discounting is geometric. That is, it's based on our achievements appreciating at a compound rate of interest. However, we may have other motivations for valuing the state of our ecosystem in the future, such as ensuring it's available for future generations. Intergenerational and hyperbolic discounting are alternative approaches that prioritise achievements differently over time (see Figure 1). Geometric discounting focuses on short-term rewards, intergenerational discounting additionally places substantial weight on medium-term achievements, while hyperbolic discounting attaches almost the same importance to medium-term through to very long-term achievements.

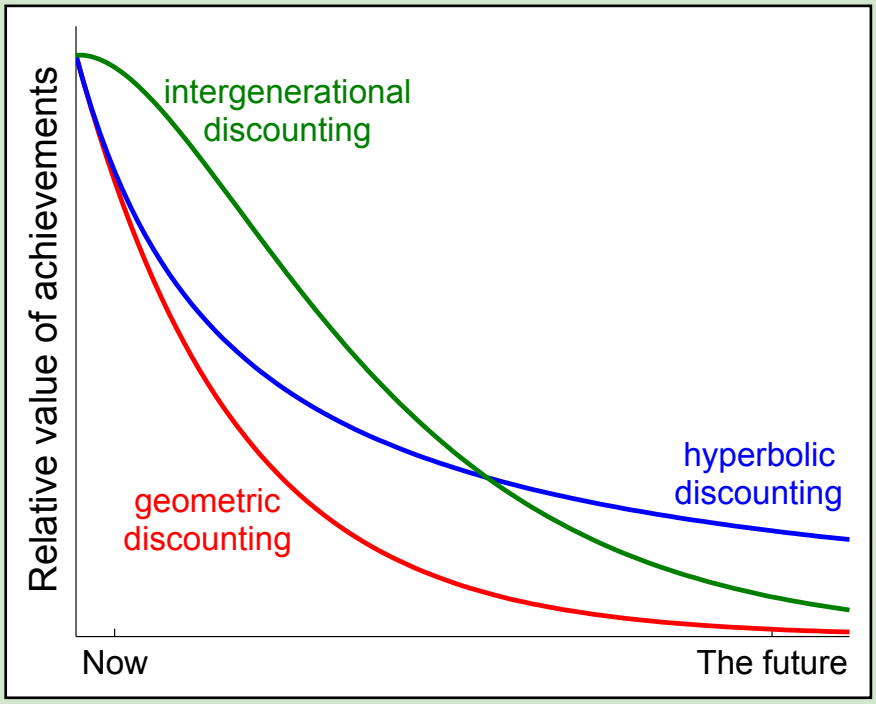

Figure 1. The relative value of achievements over time under geometric, hyperbolic and intergenerational discounting.

Plenty of adaptive management studies have included geometric discounting, but PhD student Alana Moore (from the University of Melbourne) is the first researcher to test how other discounting approaches affect the experimental side of active adaptive management.

All discounting diminishes the value of experimentation. However, she found that geometric, hyperbolic and intergenerational discounting methods each produced their own unique adaptive management strategies. Furthermore, the hyperbolic and intergenerational approaches do not necessarily encourage more experimentation than geometric discounting.

What is adaptive management?

In the last issue of *Decision Point #17*, we discussed how to take an adaptive approach to managing an ecosystem. It's a structured process of identifying our goals, articulating our uncertainty about how the ecosystem works, drawing up a management plan, and then observing, learning and adapting as we manage.

A passive adaptive manager develops their management plan on the balance of current evidence, while an active adaptive manager also considers how their actions affect their rate of learning. This allows the active adaptive manager to assess whether short-term management 'experiments' might, overall, yield better management based on better understanding.

(This first information sheet on adaptive management can also be downloaded from the AEDA research themes page.)

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Time frames

When we set clear objectives for management, we also need to identify the time frame over which we hope to achieve these goals. We can measure our success periodically over the time frame (eg, annual fishery profits, annual damage to agriculture caused by a noxious weed) or only once, when the time has expired (eg, how many hectares of revegetated land satisfy biodiversity standards after 20 years? Is our threatened species extant or extinct in the wild after 50 years?).

When considering active adaptive management over short to medium time frames the optimal strategy may require the manager to be extra cautious.

For example, in considering strategies for revegetation, we might actively experiment early on with different planting densities if we were in a position to consider the gain over a very long time frame. However, if we are only going to monitor the return over a medium time frame it's likely we won't get a decent return for our experimental effort.

It makes sense that experimental management may not be worthwhile when our time frame is short. If we experiment and jeopardise our goals at the beginning, we will probably need quite some time to learn about the system and make up for our losses with superior management based on better understanding. If it's important to achieve our goals over a short time frame then we are probably better off making do and acting on the limited information we already have, while still adjusting our actions if we see new clues along the way.

Until now, prominent mathematical studies of active adaptive management have adopted long time frames, on the scale of decades or centuries. Mathematicians sometimes even determine the optimal management strategy over an infinite time frame! However, managers may also be faced with problems where there are only a handful of opportunities for monitoring, learning and adapting before the success of the project is evaluated. During my PhD studies at the University of Queensland, Hugh Possingham and I developed a model of adaptive management and investigated the merits of experimental actions over a variety of time frames. What we discovered was quite a surprise.

Our model was consistent with prevailing thought over long time frames – when there's substantial uncertainty about the best way to manage our ecosystem, some early experimentation is beneficial. However, over medium-length time frames (such as 10-15 years), the optimal active adaptive strategy may be extra cautious. Actions that could cause ecosystem damage are avoided, even if that risk is acceptable under the 'balance of current evidence' passive adaptive strategy.

Let's consider the potential implications for some examples:

1. On the balance of evidence, we can probably yield higher catches and profits if we allow our fishery to grow a little larger than we do currently. However we're better off maintaining the status quo rather than risk the possibility that a change will actually yield lower catches.

2. We have a choice between two herbicides to control a weed infestation. One has been shown to perform moderately well in similar environments; the other has shown excellent results in other environments but it's unclear how well it could perform here. We choose the first herbicide for its reliability – we think the second one might be more effective but won't take the small risk that it could fail.

3. We continue to revegetate all land at the same planting density, even though we're 55% sure that a lower density will yield higher success per dollar spent.

4. We concentrate our re-introduction efforts at a location that the threatened species was known to inhabit 10 years ago, ignoring other locations that might be even better suited because the species hasn't been observed there in the past.

In all these scenarios there is an alternative management strategy that is predicted to give slightly better results, on average, but it's surrounded by substantial uncertainty. Over medium time frames, there is insufficient time to learn, adapt and recover any losses incurred while learning. An action that is reliable, albeit probably inferior, is preferable. Thus, the active adaptive manager may be a model of caution rather than daring experimentation.

References

Hauser CE and Possingham HP (2008) Experimental or precautionary? Adaptive management over a range of time horizons. *Journal of Applied Ecology* 45: 72—81.

Moore AL, Hauser CE and McCarthy MA (in press) How we value the future affects our desire to learn. *Ecological Applications*.

More info: chauser@unimelb.edu.au

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Experimental, neutral or cautious?

These new studies highlight the importance of carefully defining our goals and values as they relate to time. This will determine whether the best adaptive management plan is experimental, neutral or cautious.

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