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Know your ecological thresholds

By Andrew Bennett and Jim Radford

Identifying and using 'ecological thresholds' in land management and conservation may be new for many people, but the idea behind it is familiar to us all. Thresholds are common. We all know that if you lower the temperature of water, it turns into ice at around 0°C. That's a threshold temperature at which a relatively rapid transition occurs from one state to another—from water (a liquid) to ice (a solid). Ecologists are now looking for thresholds in natural and agricultural systems and starting to apply the principle as a way of better understanding these systems.

An 'ecological threshold' in natural systems refers to a point at which relatively rapid change occurs from one ecological condition to another. In nature, few relationships show constant change in one thing (attribute) in response to another. Rather, they mostly show points or zones at which marked change in one attribute occurs in response to a small additional change in one or more influential factors.

For example, consider the effect of isolation on the ability of animals to move between habitats (see box on page 3). The threshold may be in the size of the gap between habitats beyond which animals are no longer able to cross. Consider also the relationship between fire frequency and the occurrence of seed-germinating plants. Such plants require a certain amount of time (measured in years) to grow and set seed. If fires are more frequent than the time that plants require to set seed, the species will be lost from the community: a fire frequency threshold. Finally, thresholds may also relate to ecosystem processes and functions—consider the example of vegetation on a stream bank and its effect on erosion. As the percentage of ground cover is reduced, erosion is more likely to occur.

As for all natural systems, things are more complex than they might first appear. In the first example, there may be factors other than distance that are relevant to the gaps between habitats, such as the type of vegetation cover in the gap. The isolation thresholds also differ between animal species with different habitat requirements and mobility.

What happens when thresholds are crossed?
We can see the consequences of crossing ecological thresholds in many landscapes: saline seepages, rising groundwater, eroded soils, 'dieback' of paddock trees, algal blooms in waterways, and loss of plant and animal species. In each case, the 'normal' functioning of the ecological system has been altered by land use, which results in a change in ecological processes or species interactions that maintain the system, leading to a new state.

Such consequences can cap agricultural production, limit the ability for producers to diversify and have a direct effect on profitability. They also can have serious consequences for native plants and animals.

Are these ecological changes reversible? Can we simply change management practices and move the system back to a more sustainable condition on the other side of the threshold? At this stage, experience in landscape restoration is too limited to answer these questions conclusively. Many revegetation programs proceed on the assumption that the effects of excessive clearing can be reversed, and that the values of native vegetation will be restored once sufficient vegetation is returned to the landscape. This may be true for some functions of native vegetation.

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An understanding of ecological thresholds offers new insights into land management because it is based on knowledge of how natural systems work and it informs us about precautions we can take to prevent excessive disturbance and degradation. Identifying thresholds provides potential targets for restoration for which there is some confidence that sustainable ecosystem functions can be achieved.

One of the challenges will be translating regional-scale thresholds to on-ground action at the property level.

**Be careful using thresholds**

Ecological relationships are complex, often vary regionally, and may be different for areas where predominant land uses vary. So we need to be careful about the use of thresholds for management.

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CSIRO scientists Sue McIntyre, John McIvor and Neil MacLeod, for example, used a panel of experienced practitioners to identify critical points in the relationships between vegetation cover and ecosystem function in grassy eucalypt woodlands in south-east Queensland. The panel recommended minimum standards, on the 'safe' side of the perceived threshold level of change, for woodland cover, tussock grass cover, and other environmental indicators.

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"Nature is full of thresholds layered upon thresholds.”

(Wiens et al. 2002)
First, the changes we observe may be associated with several (or many) interacting factors, rather than a single causal agent. So, there may be seemingly simple thresholds that are complex to manage and we may not be able to modify all the factors or agents.

Second, different species and processes may have different threshold responses to the same disturbance or land use change. So, we need to be careful about making decisions with limited knowledge.

Third, species can respond to the environment in different ways in different regions. So, caution is required in applying thresholds and associated guidelines to geographic areas outside (or different from) those where the relationship has been demonstrated.

**More Information**

The Native Vegetation R&D Program of Land & Water Australia currently supports a number of projects that will offer new insights on this topic. Further research is urgently needed to identify threshold responses as a basis for management guidelines and as an input to regional planning.

van der Ree, R, Bennett, AF & Gilmore, DC (in press), 'Gap-crossing by gliding marsupials: thresholds for use of isolated woodland patches in an agricultural landscape', *Biological Conservation*.


**Contact**

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**Isolation threshold for the Squirrel Glider**

The effect of isolation on the way in which animal species use habitats is one area in which thresholds are frequently observed. For example, Rodney van der Ree and colleagues at Deakin University investigated the occurrence of Squirrel Gliders in 91 tree clumps in paddocks adjacent to roadside vegetation. Gliders were recorded in around 40-50 per cent of clumps isolated by less than 50 metres of farmland. However, the frequency at which clumps were used dropped dramatically at between 50 and 100 metres and only one tree clump isolated by a distance greater than 100 metres was used (see figure). There is a simple explanation for these results. Squirrel Gliders are known to have a maximum gliding distance of about 80 metres. Therefore, a threshold exists at about this distance beyond which tree clumps are too isolated to reach by gliding. The management implication is clear: to encourage movements of gliders, gaps between trees need to be less than the threshold, preferably less than 50 metres.