



Review paper

Application of habitat thresholds in conservation: Considerations, limitations, and future directions



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ABSTRACT

Habitat thresholds are often interpreted as the minimum required area of habitat, and subsequently promoted as conservation targets in natural resource policies and planning. Unfortunately, several recent reviews and messages of caution on the application of habitat thresholds in conservation have largely fallen on deaf ears, leading to a dangerous oversimplification and generalization of the concept. We highlight the prevalence of oversimplification/over-generalization of results from habitat threshold studies in policy documentation, the consequences of such over-generalization, and directions for habitat threshold studies that have conservation applications without risking overgeneralization. We argue that in order to steer away from misapplication of habitat thresholds in conservation, we should not focus on generalized nominal habitat values (i.e., amounts or percentages of habitat), but on the use of habitat threshold modeling for comparative exercises of area-sensitivity or the identification of environmental dangers. In addition, we should remain focused on understanding the processes and mechanisms underlying species responses to habitat change. Finally, studies could that focus on deriving nominal value threshold amounts should do so only if the thresholds are detailed, species-specific, and translated to conservation targets particular to the study area only.

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1. On the applicability of habitat thresholds for conservation

'Magic bullets' (Huggett, 2005) and 'magic numbers' (Flather et al., 2011; Lindenmayer et al., 2005) in ecology have an undeniable draw to conservationists and ecosystem managers. As global and regional species extinction risk increases, immediate conservation actions are required to ensure that both species and their habitats will persist. Ideally, such actions would be based on careful analyses of species- and area-specific long-term data. However, as these data are not currently available for all species and regions, we often see no choice but to rapidly implement generally applicable conservation targets (Brook et al., 2011; Flather et al., 2011). Social factors and economic trade-offs add to the pressure to obtain such targets in a rapidly changing world (Wilhere, 2008). However, there are issues concerning the search for general conservation targets—targets such as a minimum population sizes or minimum amounts (or areas) of habitat that need to be protected to ensure species persistence (Akçakaya et al., 2011; Cardillo and Meijaard, 2012; Flather et al., 2011; Lindenmayer and Luck, 2005). Interpreting habitat thresholds, amounts or percentages of habitat at which we see dramatic changes in the state (e.g., measured through persistence probability) of a population or species, as conservation targets (e.g., interpreting a habitat threshold found at 30% forest cover across a specific landscape as evidence that we should consider 30% forest cover as a minimum forest cover required for species persistence) may be especially problematic because thresholds vary largely across species and regions (Rhodes et al., 2008; van der Hoek et al., 2013, *in press*). In addition, conservation practitioners might not be aware of the many sensitivities (Swift and Hannon, 2010), confounding factors (Ewers and Didham, 2006) and potential pit-falls that plague threshold studies (Lindenmayer and Luck, 2005; Suding and Hobbs, 2009; Wilhere, 2008).

Throughout the last decades, ecologists have focused on the applicability of habitat threshold studies for conservation (Andrén, 1994; Johnson, 2013; Lindenmayer and Luck, 2005; Mönkkönen and Reunanen, 1999; Swift and Hannon, 2010). Johnson (2013) argues, like Lindenmayer and Luck (2005) before him, that there are limitations to applying ecological thresholds to conservation efforts. Similarly, earlier work (e.g., by Betts et al., 2010; Ewers and Didham, 2006; Ficetola and Denoel, 2009; Villard and Jonsson, 2009) focused on the sensitivities of threshold models and estimates and lead to a general consensus that thresholds largely depend on factors such as the statistical approach used, the scale of the study, the focal species, and the geographic location of the threshold study.

The messages of caution that Johnson (2013) and others bring forth are timely and well-justified because overgeneralization and simplification of habitat thresholds in management documentation is still commonplace (e.g., *Environment Canada*, 2013; Kennedy et al., 2003; McAfee and Malouin, 2008; Rompre et al., 2010; Wallace et al., 2003); a development that can potentially prove counterproductive to our ultimate goals of reducing, halting or reversing extinction risk. However, these nuanced messages of concern and caution do not always seem to filter through to policy makers and practitioners. We propose that pointing out pitfalls and bringing forward cautionary messages alone does not sufficiently decrease misinformed application of thresholds in conservation and management. Therefore, we suggest a focus on conditions under which habitat threshold studies *do* hold strong potential for conservation and management, to more effectively steer managers away from the pitfalls of the 'magic number' approach. To that purpose, we highlight the prevalence of oversimplification/over-generalization of results from habitat threshold studies in policy documentation, the consequences of such over-generalization, and directions for habitat threshold studies that have conservation applications *without* risking overgeneralization.

2. Over-generalization: dissemination and communication of threshold findings to policy makers and practitioners

Scientists and managers interested in the application of habitat thresholds for conservation have raised concerns on the dangers of overgeneralization. For example, Ranius and Fahrig (2006) state that "within a forest region there are thousands of species with different habitat requirements", and that "it will never be possible to summarize the requirements for biodiversity conservation in simple rules". Unfortunately, these cautionary points are sometimes ignored in actual policy documentation. As most of such documentation is not peer reviewed, and cannot always be found following systematic reviews, we decided to opt for a simpler search (using the keywords 'threshold habitat conservation guidelines' in the search engine Google) to at least evaluate whether there is any evidence of the use of threshold/minimum amounts of habitat as conservation target in policy or management guidelines as drafted by advisory committees, non-governmental agencies, governmental institutions, or similar organizations (and whether such use was justified and done in a proper manner). We opted to assess the first eight papers and reports we found in this manner (Table 1), and found evidence of potentially misleading generalizations in at least four of these. Although it is difficult to extrapolate from such a simple review – as we are not looking for peer-reviewed papers in a database we are basically searching the entire internet, hence our restriction to the first eight papers – we can at least conclude that potentially dangerous that overgeneralizations or misuse of thresholds happens (we cannot comment on the commonness of such actions).

We acknowledge that an assessment of 'proper use' of thresholds in conservation guidelines is a rather subjective matter, and also point out that most papers included both generalizations as well as disclaimers and species- or area-specific information, none were strictly 'misusing' or 'properly applying' the threshold concept. Nevertheless, we found the species-specific considerations of thresholds as conservation targets as presented by Wallace and Tarr (2012), McAlpine et al. (2007) and Rosenberg et al. (1999) especially good examples of how threshold studies can inform conservation without resolving in overgeneralization. We highlight the study of Wallace and Tarr (2012).

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