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EDITOR'S COMMENT

Canadian hare–lynx dynamics and climate variation: need for further interdisciplinary work on the interface between ecology and climate

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The regular population cycles in the abundance of Canadian hare and lynx is featured in nearly all biology textbooks (Stenseth 1995a). It is used by ecologists as a prime example of how interactions between predators (the lynx) and prey (the hare) might lead to regular population cycles (Krebs 2001, Begon et al. 2006). In addition, such interactions might also lead to non-cyclic population dynamic behaviour (e.g. May 1973). Although climate is known to affect the underlying nature of these population cycles (Stenseth et al. 1999), it is not fully understood to what extent climate contributes to the character of the dynamic hare–lynx population interaction. In fact, the extent of the climate influence on dynamic ecological systems has been passionately debated within the field of ecology for almost a century: Elton (1924) focused on intrinsic factors as the key determinants of the observed population dynamics of natural populations, while Andrewartha & Birch (1954) argued the importance of extrinsic factors such as climate. Although the pioneers within this debate favoured an either/or categorical view, it is now generally agreed upon that both intrinsic density-dependent factors and extrinsic density-independent factors determine the observed population dynamics (e.g. Turchin 1995). The dynamics of the snowshoe hare *Lepus americanus* and the Canadian lynx *Lynx canadensis* is a prime example for assessing the relative importance of the two factors, with climate as the main extrinsic density-independent factor. This is the topic of the paper published by Zhang et al. (2007, this issue). They demonstrate that both intrinsic and extrinsic factors contribute significantly to the observed patterns, using the classic Hudson Bay data on hare and lynx.

The hare–lynx cycle is a very good case in point. Prior to Zhang et al.'s (2007) study, it was documented that the North Atlantic Oscillation (NAO) played a structuring role for the dynamics of the hare–lynx system across the entire Canadian subcontinent, both with respect to ecology (e.g. Stenseth et al. 1999) and population-genetic structuring (e.g. Rueness et al. 2003). In short, climate was seen as a forcing ecological factor which determines the population genetic structure (e.g. Stenseth et al. 2004a). Earlier studies also indicated that the nature of the snow might be the key physical determinant of the climate–ecology link (e.g. Stenseth et al. 2004b). Zhang et al. (2007) extend these studies by showing that another prominent climate pattern, the El Niño Southern Oscillation (ENSO), also plays a key role in the dynamics of the hare–lynx system. By so doing, they suggest that the structuring of the ecological dynamics might be more complicated than originally envisioned by Stenseth et al. (1999), who suggested that regional differences in climate driven by the NAO resulted in a geographic grouping of lynx population dynamics.

Large-scale climate phenomena such as the NAO and ENSO are potentially of great importance to ecologists (e.g. Stenseth et al. 2003). Such climate phenomena are essentially packages of weather (cf. Stenseth & Mysterud 2005) having a much greater influence on ecosystems than single weather features: what influences living organisms is a combination of various weather components integrated over some window of time and space (the magnitude of which is not easy to assess). Therefore, empirical studies have demonstrated that indices of large scale climate modes are better predictors than individual weather parameters

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(e.g. Hallett et al. 2004, Stenseth & Mysterud 2005), which have traditionally been favoured by ecologists.

As I see it, it remains a major interdisciplinary challenge to further understand why this is so. It is my hope that there will be more interdisciplinary work addressing such ecology–climate issues, that also involves the important input of statisticians. Zhang et al.'s (2007) study suggests that such interdisciplinary work could help to further our understanding of the ecological effects of climate change. In the future, it is conceivable that we may see dramatic changes in the hare–lynx cycle due to climate change. I suggest that studies of the hare–lynx cycle, such as that of Zhang et al. (2007), provide valuable insights into this field, just as the study of this cycle has played an instrumental role in the development of general ecological theory. An interdisciplinary journal such as Climate Research would certainly be an ideal forum for reporting such work that interfaces between climate and ecology.

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