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# How apparent competition and predator responses led to the decline of Arctic ground squirrels in the boreal forests of the southwest Yukon

Jeffery R. Werner<sup>A,D</sup>, Elizabeth A. Gillis<sup>B</sup>, Rudy Boonstra<sup>C</sup>, and Charles J. Krebs<sup>A</sup>

<sup>A</sup> Department of Zoology, University of British Columbia, 6270 University Boulevard, Vancouver, BC V6T 1Z4, Canada.

<sup>B</sup> Department of Resource Management and Protection, Vancouver Island University, 900 Fifth St, Nanaimo, BC V9R 5S5, Canada.

<sup>C</sup> Division of Life Sciences, University of Toronto at Scarborough, 1265 Military Trail, Scarborough, ON M1C 1A4, Canada.

<sup>D</sup> Corresponding author. Email: [werner@zoology.ubc.ca](mailto:werner@zoology.ubc.ca)

## Abstract

Throughout much of North America's boreal forest, the cyclical fluctuations of snowshoe hare populations (*Lepus americanus*) may cause other herbivores to become entrained in similar cycles. Alternating apparent competition and indirect mutualism via prey switching are the mechanisms behind this interaction. Our purpose is to document a change in the role of indirect interactions between sympatric populations of hares and arctic ground squirrels (*Urocitellus parryii plesius*), and to emphasize the influence of predation for controlling ground squirrel numbers. We used mark-recapture to estimate the population densities of both species over a 25-year period that covered two snowshoe hare cycles. We analysed the strength of association between snowshoe hare and ground squirrel numbers, and changes to the seasonal and annual population growth rates of ground squirrels over time. A hyperbolic curve best describes the per capita rate of increase of ground squirrels relative to their population size, with a single stable equilibrium and a lower critical threshold below which populations drift to extinction. The crossing of this unstable boundary resulted in the subsequent uncoupling of ground squirrel and hare populations following the decline phase of their cycles in 1998. The implications are that this sustained Type II predator response led to the local extinction of ground squirrels. Arctic ground squirrels may also have exhibited an Allee effect caused by the disruption of social signalling of approaching predators when few individuals are left in a colony.

Key words: arctic ground squirrel, apparent competition, apparent mutualism, extirpation, functional response, indirect effects, numerical response, population cycles, predator mediated, predator prey