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Modelling long term mountain pine beetle dynamics with changing tree resilience

Over the last few decades, mountain pine beetle (MPB) have spread beyond their historical range into Alberta and threaten further spread North and East. This expansion has led MPB into novel species of pine as hosts, and their success in these species is not well understood. Climate change is also affecting pine resilience to MPB, particularly through increased drought. Accurate models predicting the long term dynamics of MPB in forests with changing tree resilience are therefore critical in assessing the risk of further expansion and informing management strategies.

In this talk, I will present a model that couples MPB population dynamics with forest growth that aims to understand how MPB dynamics will change on longer time scales and with different levels of host resilience. The model incorporates key aspects of MPB biology to realistically capture single outbreak behaviour, and has an age structured forest that regrows after MPB infestations. I will show that as forest resilience decreases, there is a fold bifurcation occurs and a stable fixed point appears with a non-zero MPB population. Simulations show that with initial conditions just above the Allee threshold, the number of beetles approaches this fixed point over a long time with transient outbreaks driven by the age structure of the forest. I will also show how adding a small number of lower vigor trees can lead to an additional stable fixed point with a small endemic population of beetles, and how with decreasing resilience can result in large outbreaks from this endemic population.