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Mathematical Model for Mountain Pine Beetle Spread and Impacts of Park Management Strategies

The current Mountain Pine Beetle (MPB, *Dendroctonius ponderosae*) outbreak has reached the highest population levels in recorded history, particularly in British Columbia. The spread and intensity of the outbreak has been largely attributed to fire suppression practices and climate change. Parks Canada has spent significant funds on management actions aimed at stemming the infestation, but the effectiveness of these measures is mostly unknown, and is difficult to determine with field work alone. Mathematical modelling is a useful tool in this work, as it can be used to investigate the effect of different management strategies without damage to the landscape or economy. My research focuses on evaluating management strategies implemented in Banff National Park (NP).

I have developed a diffusion-reaction-chemotaxis model describing MPB population dynamics and dispersal. This model incorporates the interaction between MPB, susceptible Lodgepole Pine trees, and the pheromones produced by MPB. This spatially explicit model describes the summer flight period of the MPB. A set of discrete difference equations is used to model the overwinter reproduction of MPB and the impact of MPB on the suscetible landscape. This model is run over multiple years to show the progression of MPB attack over time.

The management actions implemented in Banff NP are prescribed burning and baiting and green-attack tree removal. The prescribed burning removes possible habitat for MPB but can not be used as a tool to kill the MPB directly. Baiting is used to focus MPB attacks in an area and then intensive land surveys would be completed to determine the recently attacked trees in the fall. Since the trees attacked by MPB have not developed a red-top yet,the trees are still green. These green-attack trees are removed and burned to prevent spread of MPB.

Management actions are simulated over multiple years and the results of these simulations inform when each particular management action is the most effective at stemming the infestation of MPB.