PhD Defence - Peter Thompson

Date: Thursday, February 2
Time: 9:00 am
Supervisors: Drs. Mark Lewis and Andrew Derocher
via ZOOM

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"Mathematical methods for exploring the cognitive drivers of animal movement"

Abstract: Movement is a fundamental process that allows many animals to acquire nutrients, evade predation, and produce offspring. Its ecological importance has inspired ecologists to question where, when, and how animals move. As ecologists learn more about movement, it has been suggested that understanding why animals move connects deeply with our understanding of animal memory, learning, and cognition. Advances in animal tracking technology have produced an abundance of data summarizing these movements in wild animals, which can be analyzed to uncover informative patterns about how animals perceive and remember information about their environments. Here I present theoretical and empirical approaches for exploring memory and learning in wild animals, ranging from simulation-based approaches that incorporate existing theory on foraging and decision-making to statistical approaches that can characterize memory-informed movements from animal tracking data. I begin by introducing a statistical model that can identify how long animals wait before returning to previously visited areas. I demonstrate the model's effectiveness on simulated data before fitting it to grizzly bear tracking data collected in the Canadian Arctic. The model identifies patterns suggesting that many grizzly bears remember the spatial location and temporal availability of productive patches, which they navigate back to annually. I also introduce a novel framework for simulating decision-making and learning in animals, which leverages theoretical connections between animal cognition and Bayesian inference. The model uses Bayesian Markov chain Monte Carlo sampling techniques to simulate how animals adjust their foraging behavior to identify profitable and energy-efficient movement strategies. Different model parameters modulate the rate at which simulated animals can change these strategies, which I suggest connects to behavioral plasticity in wild animals. Simulation analyses produce results that connect further to theory about the optimality of behavioral plasticity as the environment changes. Finally, I design a model that statistically identifies the temporal extent of migration from animal tracking data. The model was accurate and efficient when fit to simulated and empirical data from multiple case studies. These modelling efforts are linked in their ability to uncover important behavioral and cognitive processes in wild animals through movement. Continuing to develop mathematical advances for modelling movement will facilitate an improved understanding of how animals think and learn as time goes on.