

## Using evolutionary algorithms to predict optimal navigational decisions through thermally-structured environments

SEARS, Michael W<sup>1</sup>; ARTITA, Kimberly S<sup>2</sup>; SHROUT, Timothy<sup>3</sup>

<sup>1</sup> Assistant Professor, Department of Zoology, Southern Illinois University Carbondale (SIUC), 355B Life Science II, Carbondale, IL 62901; Ph: (618 453-4137; Fax: (618) 453-2806, Email: [msears@zoology.siu.edu](mailto:msears@zoology.siu.edu)

<sup>2</sup> Graduate Research Associate, Department of Civil and Environmental Engineering, Southern Illinois University Carbondale (SIUC), Mail Code 6603 Carbondale, IL 62901; Ph: (618) 536-2368; Fax: (618) 453-3044, Email: [kartita@siu.edu](mailto:kartita@siu.edu)

<sup>3</sup> Graduate Research Associate, Department of Zoology, Southern Illinois University Carbondale (SIUC), Carbondale, IL 62901

A goal of contemporary studies of animal movement is to understand the mechanistic decisions that comprise navigation. To date, most ecological studies of movement use post hoc statistical models, or simulations based on empirically-derived traits, to explore the potential movements of individuals. Although much insight concerning the patterns of movement has been gained from these studies, they exhibit a degree of tautology, and subsequently don't contribute to a mechanistic understanding of how animals decide to move. Here, we demonstrate a method to predict the navigational decisions of individuals using evolutionary algorithms. Using a genetic algorithm, we can predict optimal phenotypes for movements given constraints imposed by thermoregulation and thermal heterogeneity of the environment. Specifically, we predict the perceptual range and searching patterns of an individual in a spatially-structured environment. We can describe this perceptual range using a beta distribution for the probability of searching an exploitable area at a specific distance from the individual and a circular normal probability distribution to describe the range of potential movement angles. Parameters of the probability distributions are optimized to provide a searching pattern that provides the longest duration of activity. Further optimization criteria, such as minimizing energy expenditure during movement while maximizing energy intake or minimizing predation risk, can be incorporated to provide more realistic assumptions. We further discuss how to predict alternative phenotypes using a variant of the simple genetic algorithm, known as the species conserving genetic algorithm. We propose our methodology as a framework from which to derive testable hypotheses for field studies of spatial movement in an evolutionary context.