



EFFECTS OF TEMPERATURE VARIABILITY ACROSS HABITAT SCALES ON ANIMAL DISTRIBUTION AND ADAPTATION

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ABSTRACT

A habitat is a location that has physical environmental conditions that a species associates with. Environmental conditions within a habitat are rarely uniform: they exhibit heterogeneity across spatial and temporal scales. This then drives habitat selection by individuals to occur at multiple scales and hierarchically. Habitat selection across multiple scales is shaped by species-specific traits such as mobility and body size, and temperature is one of the key factors driving it. Despite its importance, many ecological studies overlook the multi-scale nature of habitat selection, potentially misrepresenting species–environment relationships. To address this gap, this study used thermal imaging (thermography) to quantify operative temperature variation within and across three different spatial scales: micro (~ 0.08 m²; thermal image), meso (~ 10 m²; e.g., sun/shade patches), and macro-habitats (~ 100 m², across substrates), across temporal scales (comparing across days and within season), and to examine how this variation is influenced by environmental covariates. The results showed that across spatial scales, measured temperature varied significantly across macrohabitats and mesohabitats, as well as significantly affected by their interaction. It is also found that the microhabitat temperature range is significantly affected by macrohabitat, mesohabitat, and their interaction. Across the temporal scale, within a day, the microhabitat temperature range was affected by time from dawn, and by the 3-week fieldwork periods within a season. Furthermore, environmental covariates such as humidity, cloud coverage, substrate moisture condition, and vegetation coverage also affected the variation of microhabitat temperature range. These findings highlight the importance of assigning proper habitat scaling and quantifying the variation across and within those scales, which can help understand habitat selection more comprehensively. In the context of climate change, identifying habitats with strong thermal buffering capacity is critical for supporting species sensitive to thermal variation. Further research is needed to assess long-term and species-specific responses to thermal dynamics.

Keywords: Habitat scales, temperature, habitat selection