Armstrong abstract:

Alternative climate adaptation strategies can buffer populations from environmental stressors by diversifying exposure, however these varied responses can be associated with differing trade-offs. In freshwater ecosystems cold-water fish have been observed displaying intra-population variation in thermal refuge use during periods of thermal stress, where some remain in the warm mainstem and others exploit thermal refuge habitats. Moving to refugia may present a conflict between temperature and food, since consumption rates should decline with increasing fish densities. In comparison, fish that stay in the mainstem river incur higher metabolic demands, but also have higher foraging rates. Here, we demonstrate that fish exhibiting these different tactics—remaining in warm riffles or seeking thermal refuge—employ distinct energetic strategies by maximizing either energy gain or energy efficiency, respectively. For this study, we evaluated the consequences of alternative behavioral strategies in response to summer warming by integrating field-derived measurements of prey energy density, temperature, fish growth, and estimates of activity within a bioenergetics framework. While the energetic costs and benefits of each strategy were markedly different, both yielded positive growth, suggesting that both tactics represent evolutionarily stable strategies at present. However, warming temperatures are expected to penalize fish remaining in warm riffles, making this strategy less energetically profitable in the future. Our findings underscore the importance of considering intraspecific variation in response to climate change and highlight the potential role of floodplain thermal refuges in mitigating its effects.