Background/Question/Methods

Because of their high capacity for reproduction, insect populations are often naturally quite variable. In addition to internal dynamic rules governing abundance, environmental conditions and resource availability can dramatically influence the size of populations, however, dis-entangling these multiple drivers can prove a profound challenge. Yet, for invasive species and species of conservation concern alike, understanding how external drivers affect the internal dynamic rules is essential for effective management. In response to this challenge, I developed a tool for unbiased detection of shifts in dynamic regime of a population, as documented by time-series data. The tool uses an iterative, likelihood based approach to identify and quantify shifts in the internal rules governing a population’s dynamics by comparing the fit of models based on the set of all possible shift-point combinations. In this research, the Ricker population model was used, and thus the model produced estimates of r, the intrinsic growth rate, and k, the carrying capacity of the population during each phase between shifts. Once identified, shifts and changes to r and k can be examined in the context of external drivers. I apply this tool to overwintering populations of Monarch butterflies to gain insights into drivers of their dynamics.

Results/Conclusions

Numbers of monarch butterflies at overwintering sites in Mexico have been in general decline for several decades, however, there has been considerable debate in the literature regarding the rates and drivers of the observed declines. Fitting the regime shift model to observations of total area occupied by overwintering monarchs within the Monarch Butterfly Biosphere Reserve from 1994-2016 suggests an interesting dynamic with three apparent phases. The model suggests a step-wise decline in carrying capacity, with k declining by almost 56% after the 2003, and again by just over 50% after 2008. Meanwhile, an apparent 70% compensatory increase in r is observed during the shift after 2003, and this value of r remains constant during the shift in 2008. Modelling the interaction as a linear decline in k instead produces a similar, but lower-performance fit. These results will be examined in the context of land use and climate changes occurring in the Monarch’s Midwestern US breeding habitat during the time of the shifts.