Mechanistic models of species distributions have been the subject of increased testing, but recent comparisons with correlative approaches have not shown their putative benefits, which include strengthened inference due to a priori predictions based on specific mechanisms and the ability to tease apart different dynamics. Through a new implementation of a butterfly distribution model subjected to past comparisons, we show the value of this approach by testing the model using abundance data, a metric more amenable to a model that predicts performance. We show that abundances have a positive relationship to predicted growth rates, but only in the cooler parts of this butterfly’s range, suggesting an unidentified mortality source in warmer regions. This points to specific mechanisms that could be tested to improve the model. We also show how matching the year ranges of the environmental to distributional data provides a more robust test and suggests this species may not be in equilibrium with the recent climate. By testing the model in a way that takes advantage of the strengths of this approach, we were able to highlight the benefits of taking a mechanistic approach to species distribution models.

**Box 1:** The historic range of the sachem (dark grey) began to expand northward in the 1960s and by the 1990s had reached central Washington (light grey). One hypothesized cause was warming winters.

**Box 2:** Mechanistic experiments to test cold tolerance

- **Laboratory experiments**
  - Exposed larvae to environment mimicking January high/low temps in different parts of their expanding range and under different conditions and measured overwinter survival.

- **Field experiments (transplants)**
  - Overwinter survival measured for larvae collected in the Tri-cities and transplanted to both Tri-cities and Yakima (range edge).
  - A SPECIES DISTRIBUTION MODEL BASED ON COLD TEMPERATURE TOLERANCE FOR THE COMMON SACHEM SKIPPER

Mechanistic models require species-specific data on factors that impact their performance and thus require much more advance work to implement than traditional correlative (or niche) models that rely only on widely available distribution data. Previous work (Box 3) suggests that the mechanistic approach did no better when looking at predictions of presence and absence throughout their range. We suggest that to get the most out of these mechanistic models, we should use the a priori predictions of the mechanistic approach to examine specifically where the model did well or poorly to identify knowledge gaps for future research. We also examine the benefits of using abundance rather than occurrence data and also matching year-runs of climate data to distribution data for better results.

**CONCLUSIONS**

A recent comparison between Crozier and Dwyer’s 2006 mechanistic model of sachem distributions was shown to do no better at predicting presence and absence than a simple niche model (Buckley et al. 2010). However:

- Presence/absence is a test more suited to niche models whereas mechanistic models predict performance and are best compared to abundance metrics when they are available
- A priori predictions allow for tests of model strengths and weaknesses and point to specific hypotheses to be explored:
  - What underlies lower performance in warmer areas of the range?
  - Are they ignorant of too much heat (note that all the experiments in Box 2 focused on cold tolerance)?
  - Do they experience increased predation or parasite in warmer regions?
  - Are all populations in equilibrium with the current climate, or is their potential for range expansion?
- Are the two identified areas of higher abundance (Box 6) statistical flukes, or have those local populations adapted to different temperature regimes, which could be easily tested in the lab?

Although comparisons between different modeling approaches can be informative, it is also important to implement and evaluate models in ways that take advantage of their putative benefits.