Expanding the Dynamic Shift Detector Algorithm to Monitor Insect Populations Through Time

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Introduction

- **Insect populations are dynamic through time** & regulated by biotic & abiotic constrains
- Many ways to model pop. dynamics
  - Environmentally responsive & density dependent parameters, ***r* (intrinsic growth rate) & *k* (carrying capacity), control pop. dynamics**
- Understanding population fluctuations & identifying drivers of fluctuations **key to insect conservation**
- **Dynamic Shift Detector** (DSD) is an algorithmic tool designed to **model shifts in parameters in time-series abundance data**
- Original DSD uses one population model, the Ricker Model, which may not be optimal for all situations
- Here **we test different pop models in the DSD algorithm** & evaluate their performance using simulations & case studies

Methods

- **Simulations:** Simulate data with 3 different population models & underlying conditions
  - Vary noise, starting *r*, change *r*, change *k*, & series length

$$N_{t+1} = N_t \exp(r(1 - (N_t/k))) + \varepsilon_t$$

Ricker Model

$$N_{t+1} = N_t \exp(r)/(1 + \exp(r) - ((1/k)\, N_t)) + \varepsilon_t$$

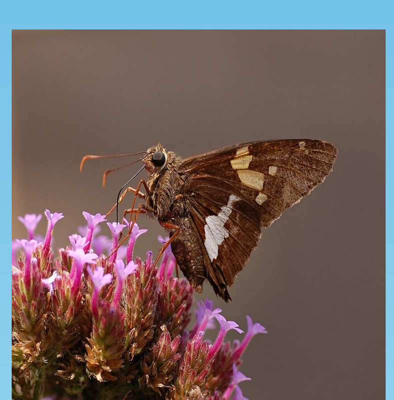
Beverton-Holt Model

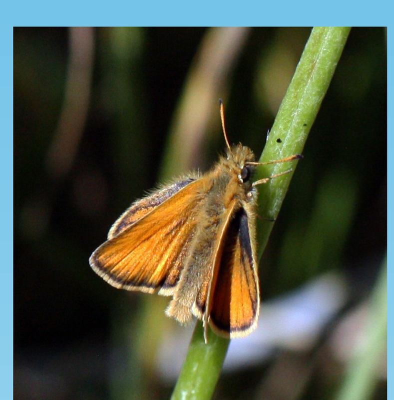
$$N_{t+1} = (N_t(r))(1 - (N_t/k)) + \varepsilon_t$$

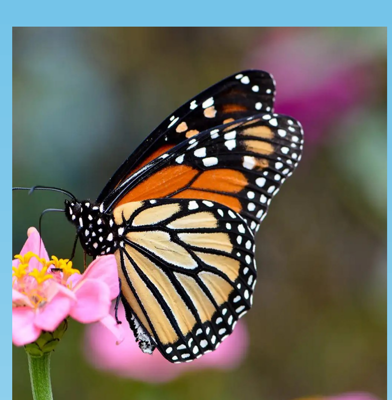
Logistic Model

r: intrinsic growth rate
k: carrying capacity

- **Case Study:** Long-term butterfly monitoring program in Cuyahoga Valley National Park
  - Applied DSD with different pop. models to 4 commonly observed species in the dataset

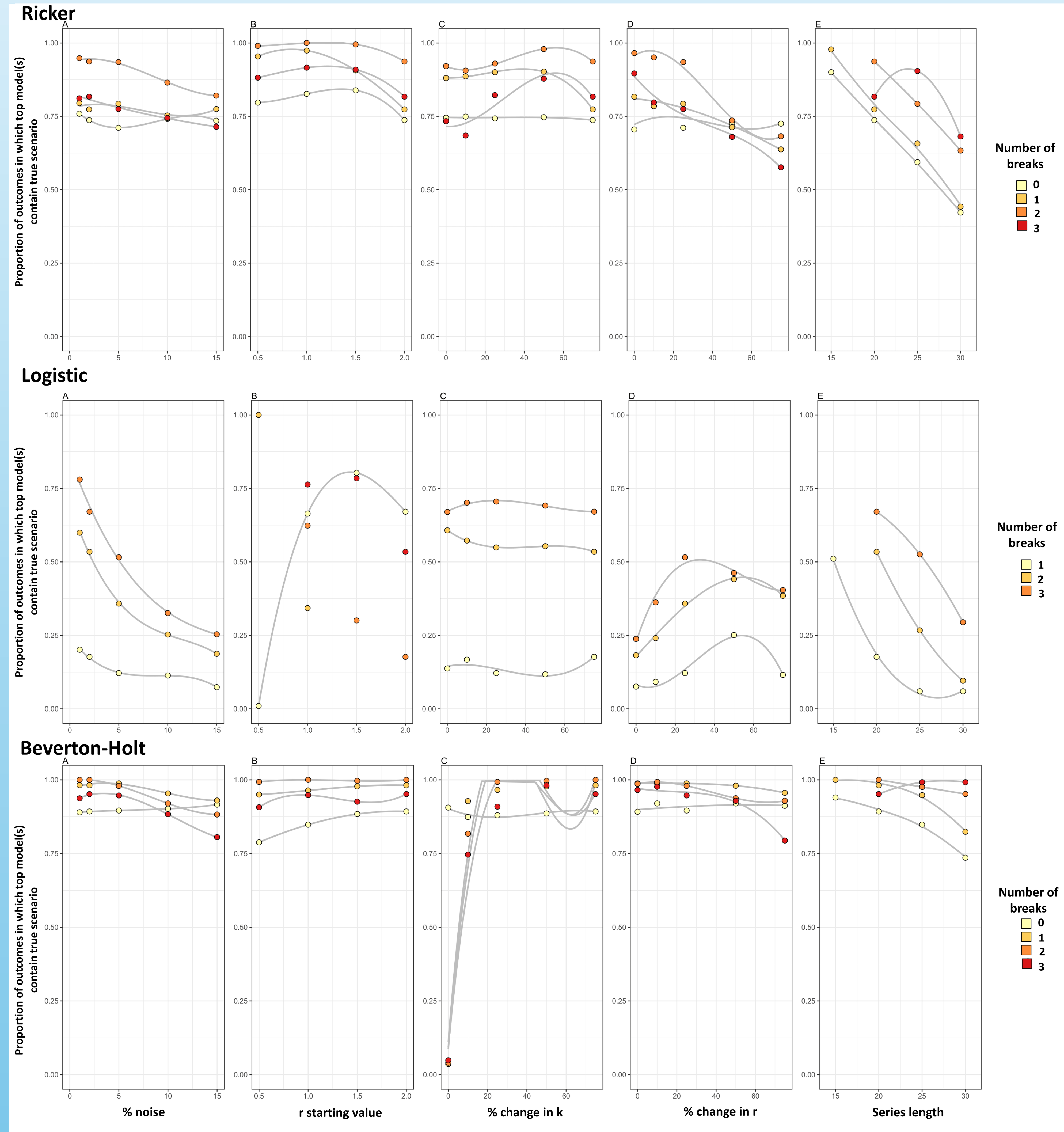

Silver-Spotted Skipper


Essex Skipper

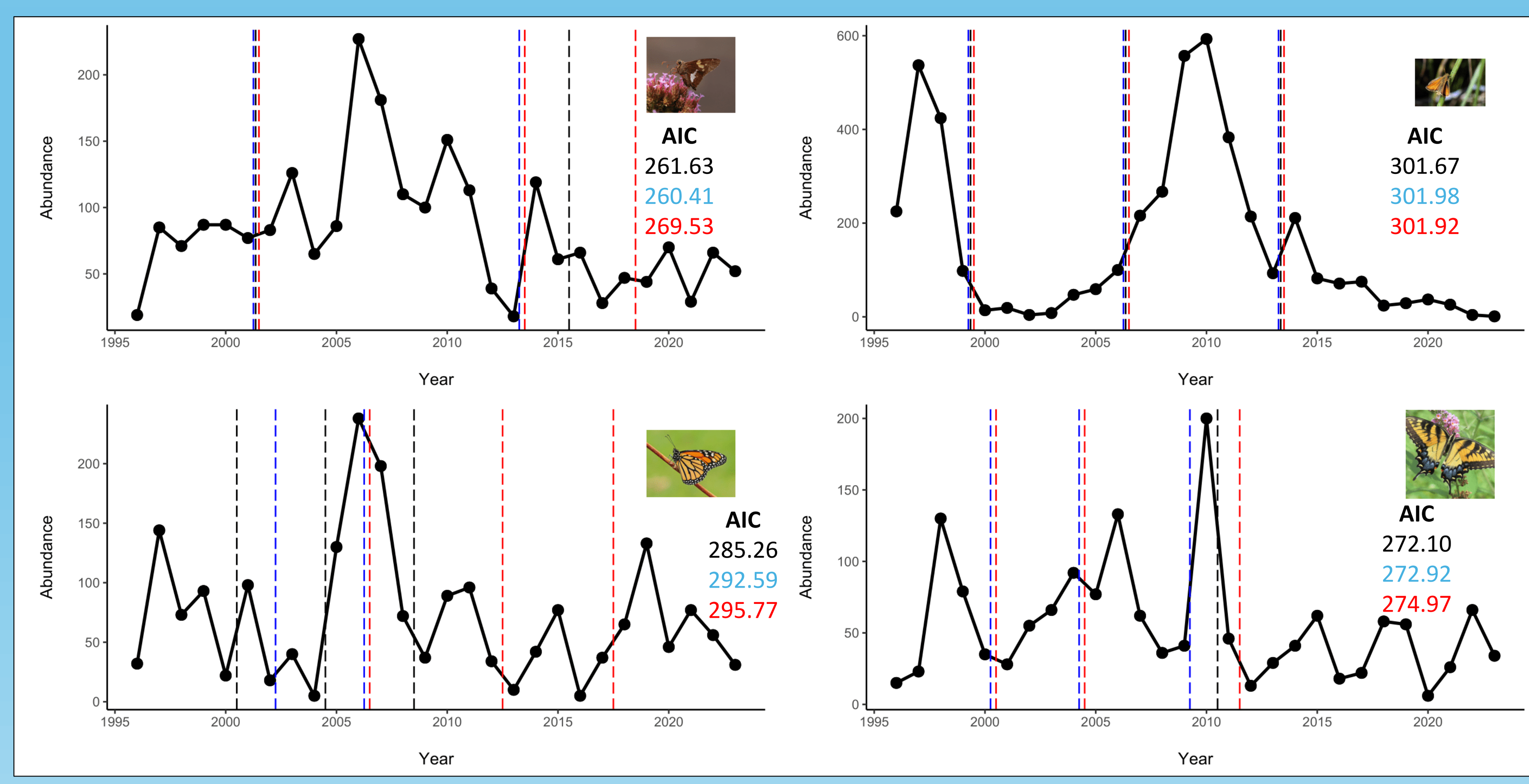

Monarch Butterfly


Tiger Swallowtail

Results: Simulations



Results: Case Study



Ricker Model
Beverton-Holt Model
Logistic Model

Discussion

- Simulations & case studies indicate **logistic model performs worst out of tested models**
  - Simplified model of population growth – tends to crash to 0, which is likely impacting DSD performance
- Simulations & Case studies indicate **Ricker & Beverton-Holt models produce comparable results**
- Case study **suggests environmental drivers of population change**
  - Break points align approximately with years with high degree days & low daily precipitation

Future Directions

- Test more population models
- Integrate all population models into single Dynamic Shift Detector Function
- Incorporate environmental variables to see what may be driving observed shifts
  - May need to be a different algorithm
- Investigate how DSD recovers underlying population via AIC

Acknowledgements

Thanks to Jerome Wiedmann for curating the CVNP butterfly data. Special thanks to the community scientists that have built the CVNP butterfly monitoring dataset. This work was funded via the NSF CAREER Award to Bahlai. Thank you to my colleagues in the Bahlai Lab of Computation Ecology at Kent State University.

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