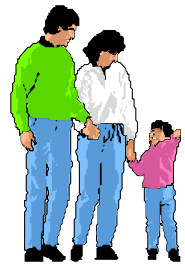
Dynamics of Arbovirus Transmission



St. Louis Encephalitis and West Nile viruses in South Florida

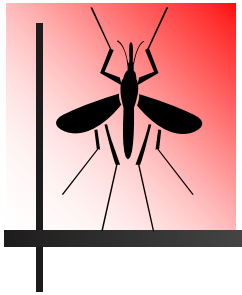
Cynthia C. Lord

University of Florida-IFAS

Florida Medical Entomology Lab

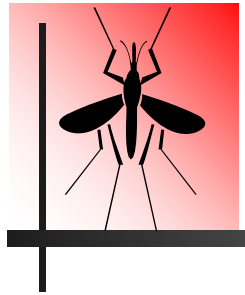
UNIVERSITY OF FLORIDA IFAS

IFAS FMEL Florida Medical Entomology Laboratory UNIVERSITY OF FLORIDA



What are dynamics?

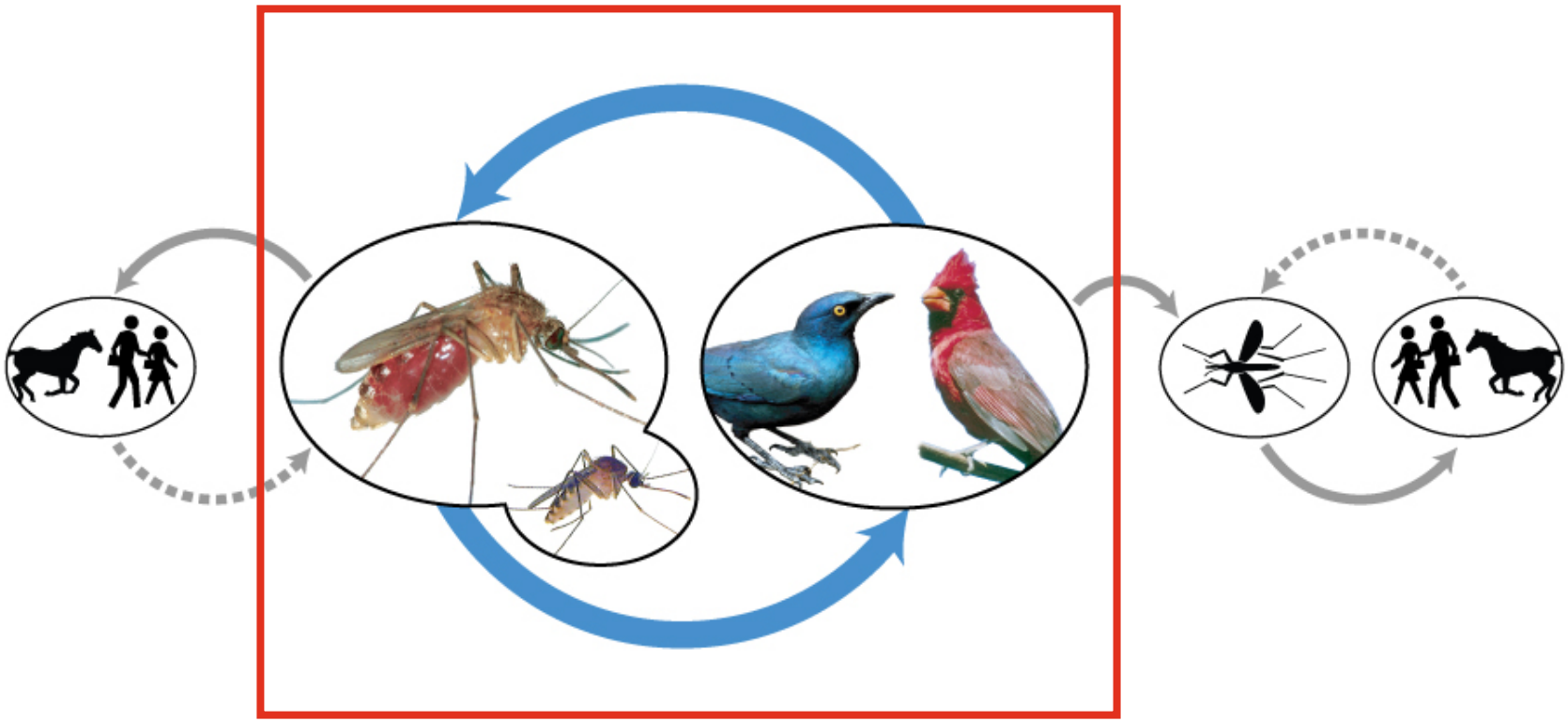
- Changes in time - and space
- May be monitored or modeled at different scales
  - Single season
  - Between years
- Scale used depends on questions asked



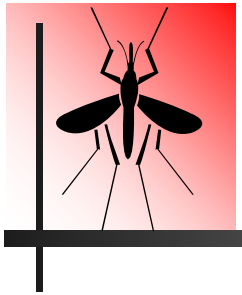
Arboviruses in Florida

- St. Louis encephalitis virus
  - South Florida – vector *Culex nigripalpus*
  - Bird-mosquito cycle
  - Human infection incidental
- West Nile virus
  - Vectors varied, *Culex* species dominant
  - Bird-mosquito cycle
  - Human & domestic animal infection incidental

Arbovirus Transmission cycle



Models of transmission dynamics

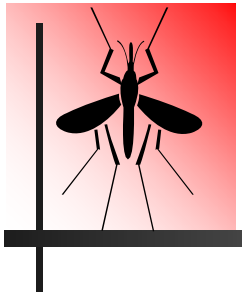


Model development: questions

SLEV in Florida

1. Can variation and seasonality in mosquito vectors explain variability in SLEV transmission dynamics? **No!**

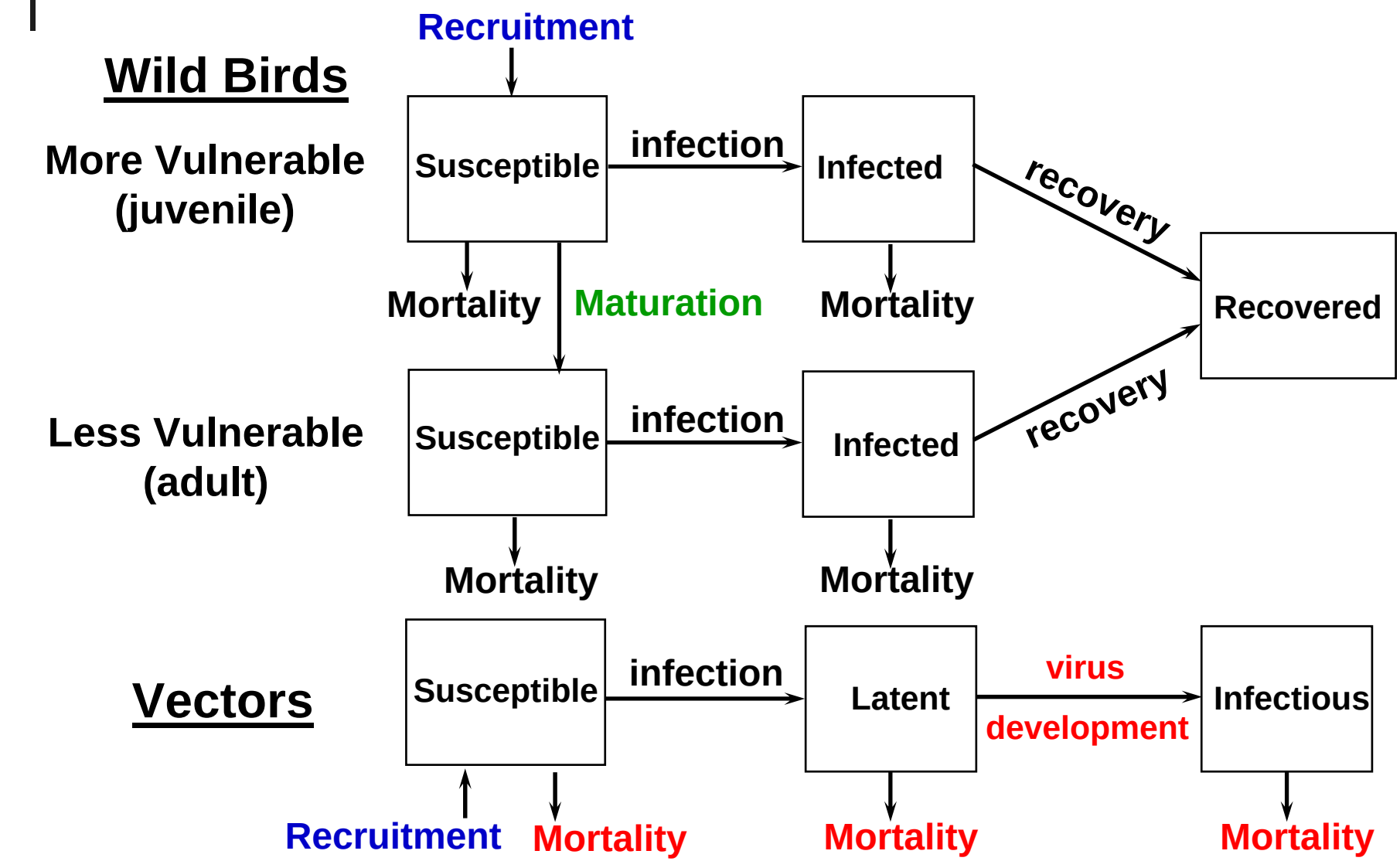
2. How does seasonality in bird populations interact with mosquito populations to affect transmission?

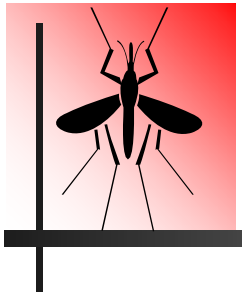


Model structure & assumptions

- Assumptions are a key part of a model
- Keep the model simple
  - still addressing the question
- Need to include
  - Seasonal dynamics in mosquitoes and birds
  - Temperature effects
- One species of mosquito
  - populations described based on field data
  - Variation in seasonal patterns
- One host species with two age classes
  - Seasonal reproduction

Flow Chart of Model

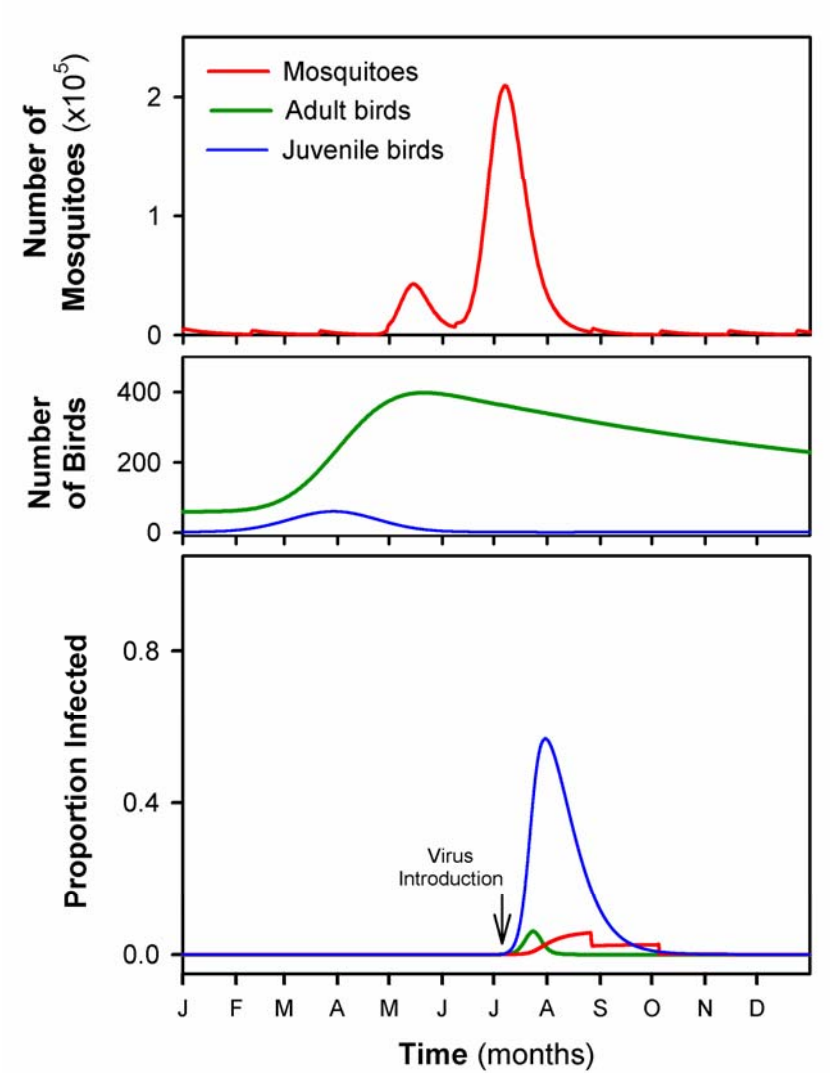




Incorporating variability

- Sources of variability
  - Biological: spatial, temporal, species
  - Gaps in knowledge
- Sensitivity analysis
  - Explore the parameter space
  - Assess consequences of variability
- Analysis
  - Outcome: is there an epidemic in birds?
  - Statistical analysis: the contribution of each parameter to the outcome of the simulation

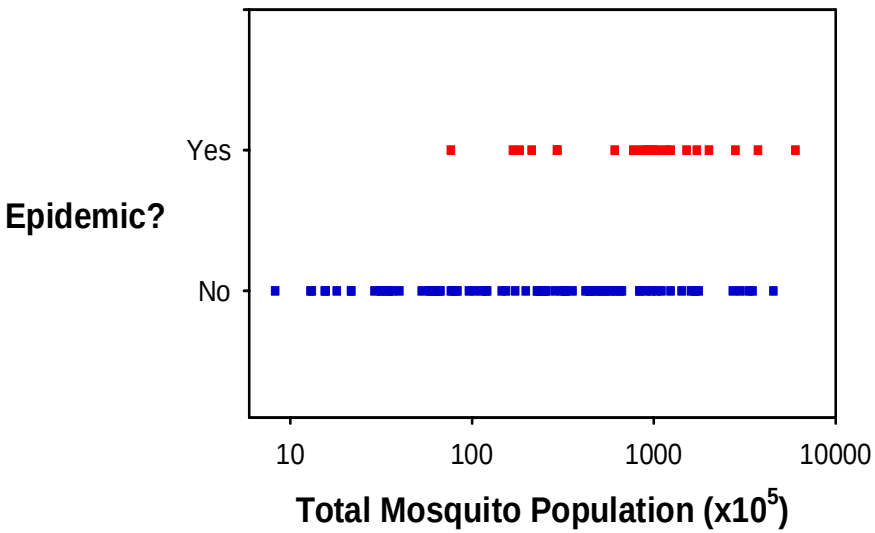
Model output

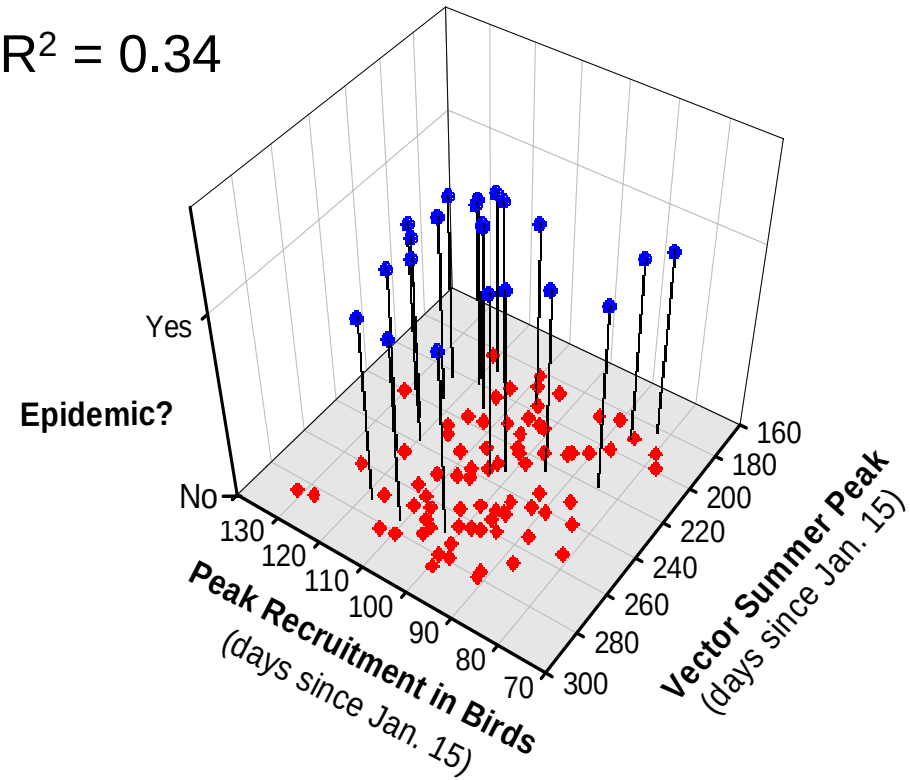


Likelihood of epidemics

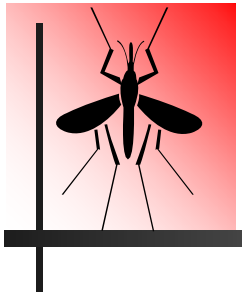
Logistic Model $R^2 = 0.34$

Mosquito population
Mosquito mortality (baseline)





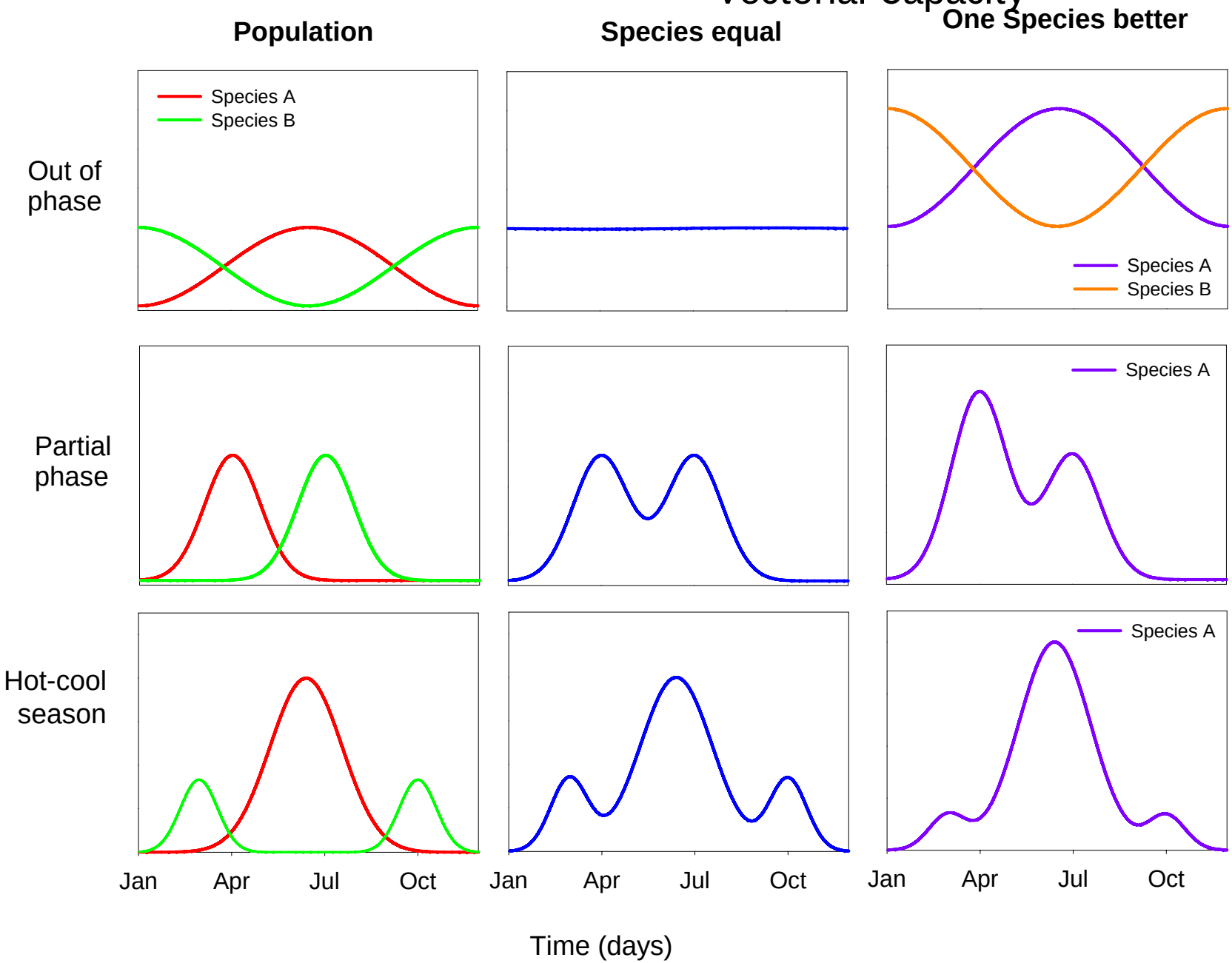
Time of peak bird recruitment
Time of summer peak in mosquitoes



Multiple vector species

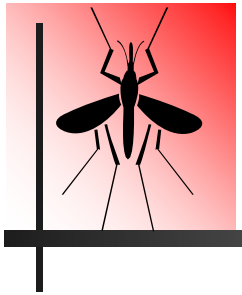
- How do multiple vector species affect transmission dynamics?
  - Tradeoffs in population abundance, vector competence, seasonality
  - Less competent vector allowing transmission during “off” season
- Work in progress!

Vectorial Capacity



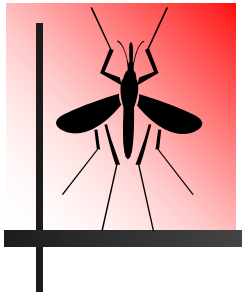
Acknowledgements

- FMEL Collaborators
  - Jonathan Day
  - Roxanne Connelly
  - Walter Tabachnick
- Technical staff
  - Leah Peak, Carol Thomas, Sara Lynn, Jonathan Fung



Size of epidemic in birds and mosquitoes

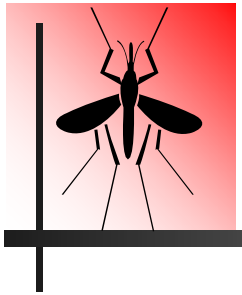
Juveniles	Adults	Mosquitoes
Juvenile recovery rate	Adult recovery rate	Mosquito population size
Transmission from adults to vectors	Days between blood meals	Spread of summer peak
Baseline mosquito population	Transmission from juveniles to vectors	Adult recovery rate
Spread of summer peak	Juvenile recovery rate	
Stepwise model R^2= 0.92	0.63	0.42



Why use models?

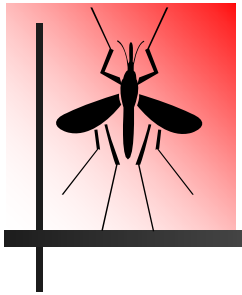
- Allow integration of many aspects of a system
- Facilitates exploration of alternate hypotheses
- Consider variability and uncertainty
- Exploration of consequences of policies or activities

- Establish research or policy priorities
- Prediction of future activity or outbreaks



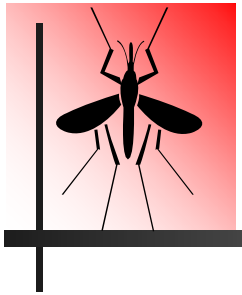
Model structure

- as simple as possible
- including critical features necessary to ask the questions
- Need to include
  - Seasonality in mosquitoes
  - Seasonality in birds
  - Other seasonal aspects: temperature effects
- Simplifications
  - Detailed population dynamics



Assumptions & Structure

- Basic structure as before
- Add second vector
  - Still descriptive, not mechanistic
  - Simplify seasonal patterns
- Include variability – differences between vector species
  - Seasonal patterns
  - Other aspects of vector competence



Planned simulations & analysis

- Selected pairs of species
  - Examine for enhancement of transmission with multiple vectors
  - Preliminary study to consider parameter ranges
- Larger sensitivity analysis
  - Increased variation in population & competence parameters
  - Statistical analysis for relationship between parameters and outcome