

Phenology Models for BMSB

Anne L Nielsen

Rutgers University

Robert McDougall

Shelby Fleischer

Penn State

Shi Chen

UNC Charlotte

Jim Walgenbach

NC State Asheville



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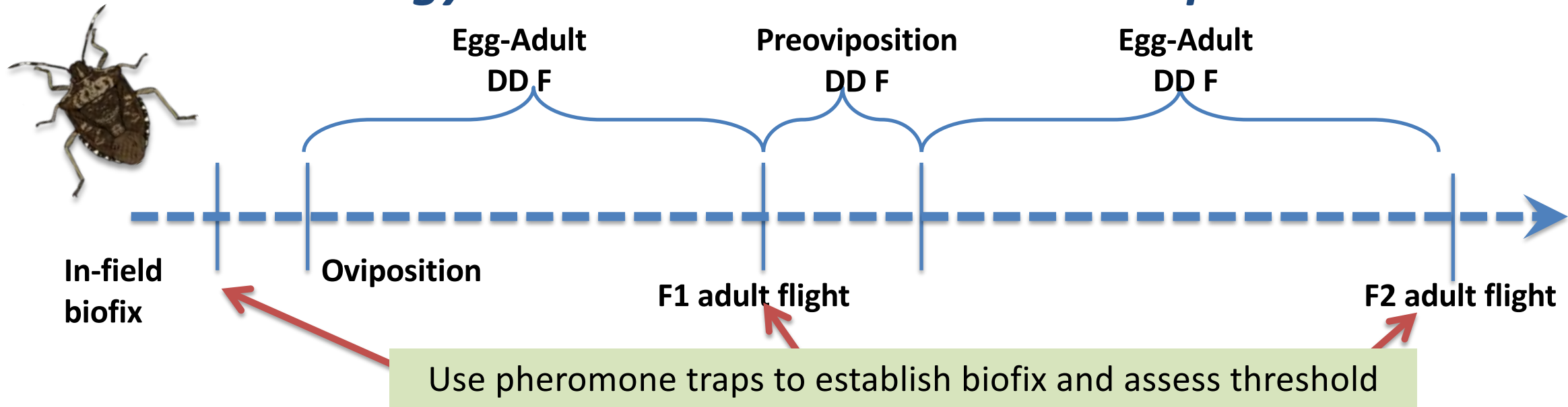
  



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Model Phenology to Make Predictions about Populations

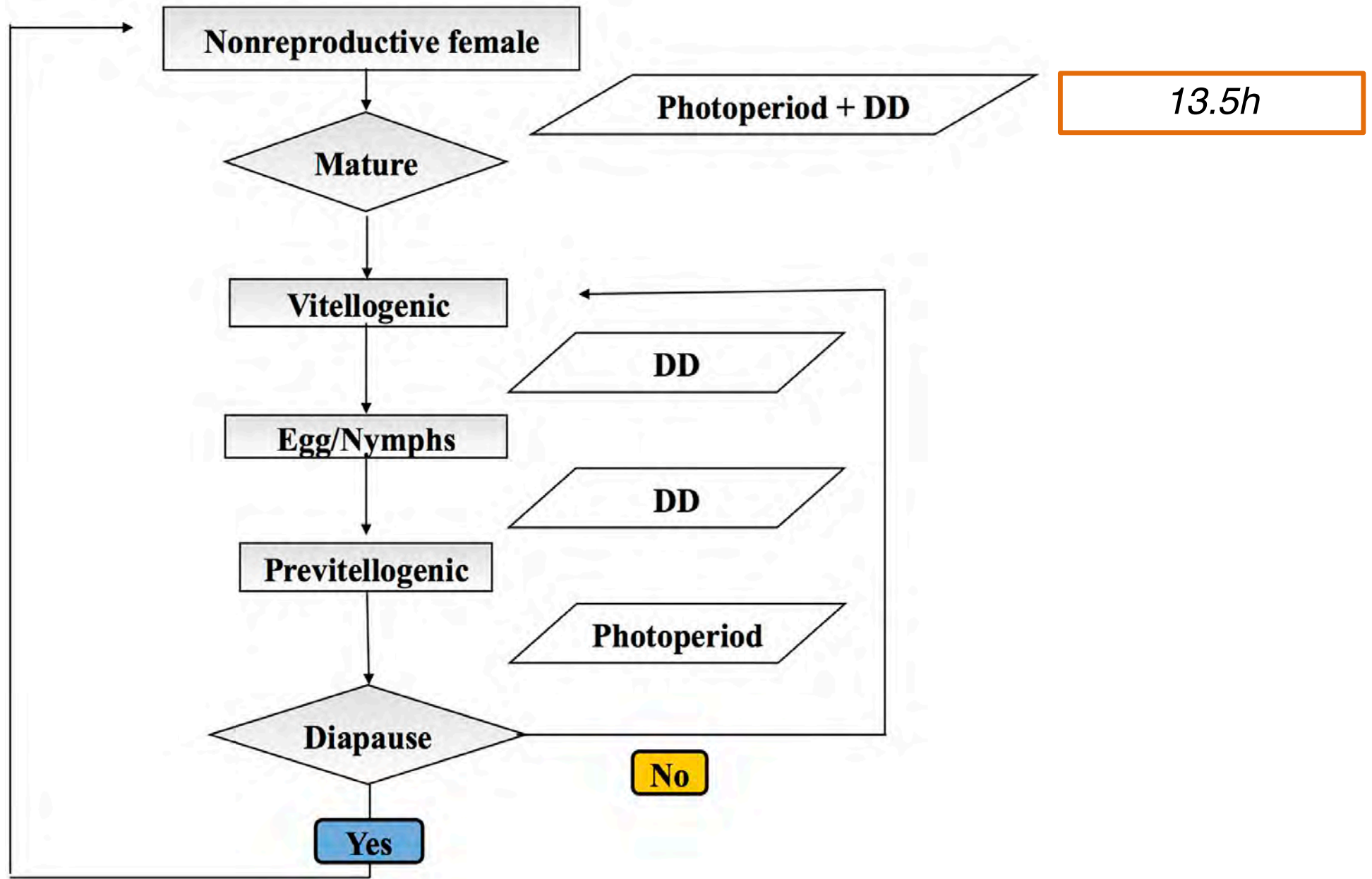


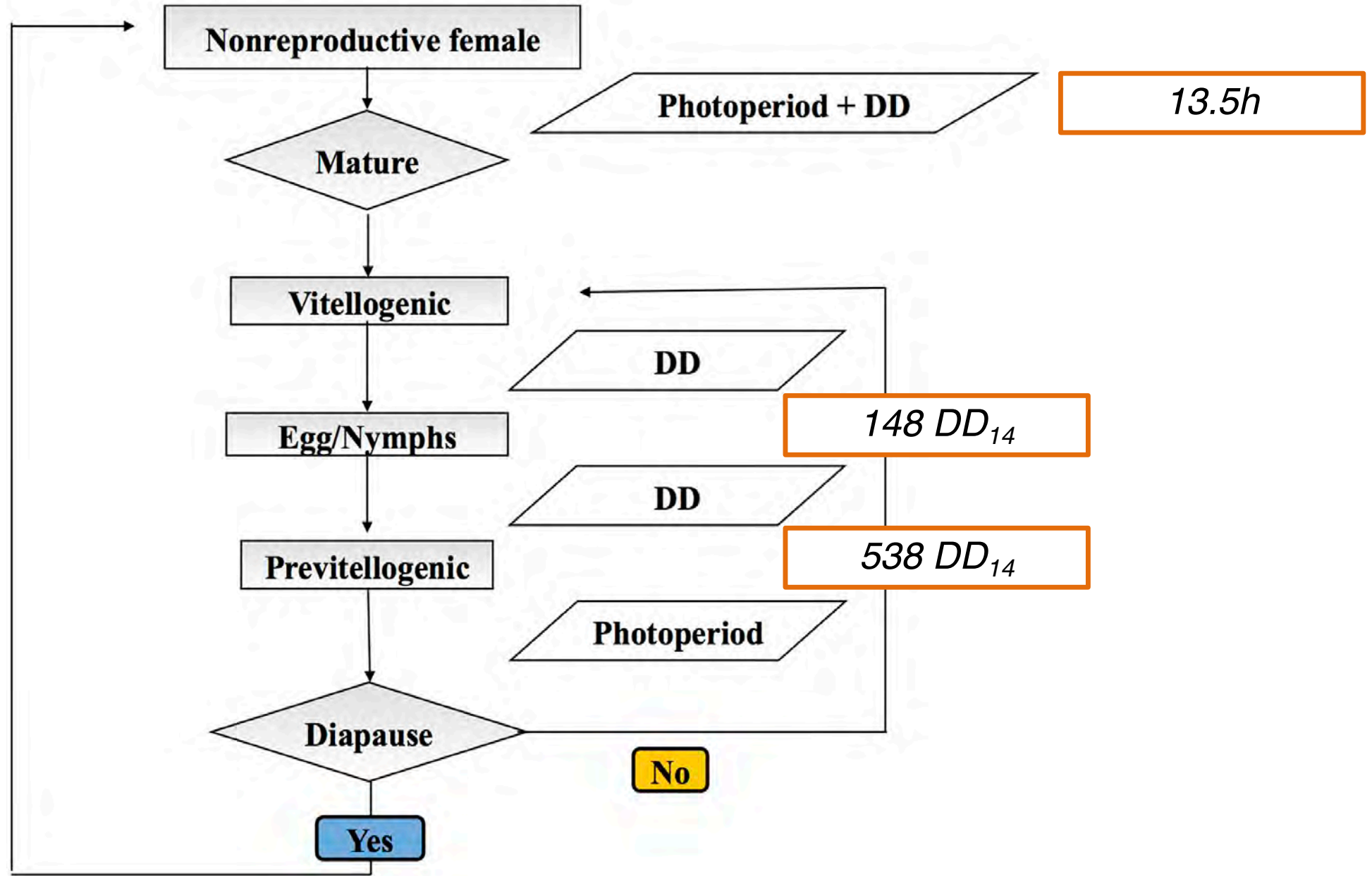
- *Extreme* overlap among life stages
- Traditional DD models lose accuracy for insects with overlapping life stages
- Traditional DD models don't incorporate mortality or physiological variation
- Simple to use and interface with weather-based software

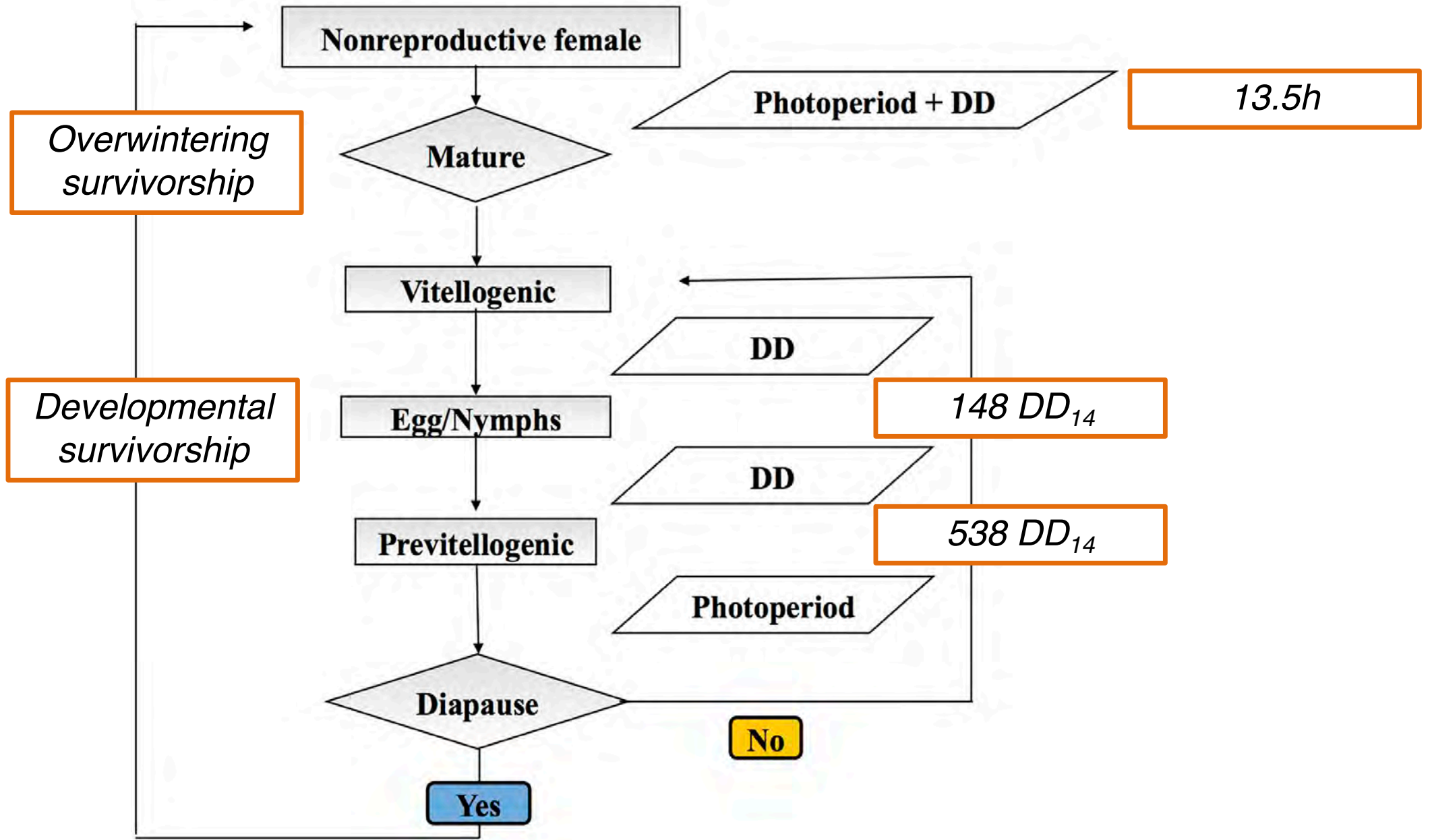
Develop an Individual Based Stage-Specific Phenology Model

Life Stage	Process	Stochastic	Drivers
Adult	Overwintering survivorship	X	Time
	Diapause termination and induction		Photoperiod
	Preoviposition		Temperature
	Fecundity (clutch size, interval, number)		Time
	Sex Ratio		
Eggs and Nymphs	Survivorship	X	Temperature and Time
	Development Rate and Thresholds	X	Temperature and Time

1000 individuals, Results pooled from 100 runs per simulation









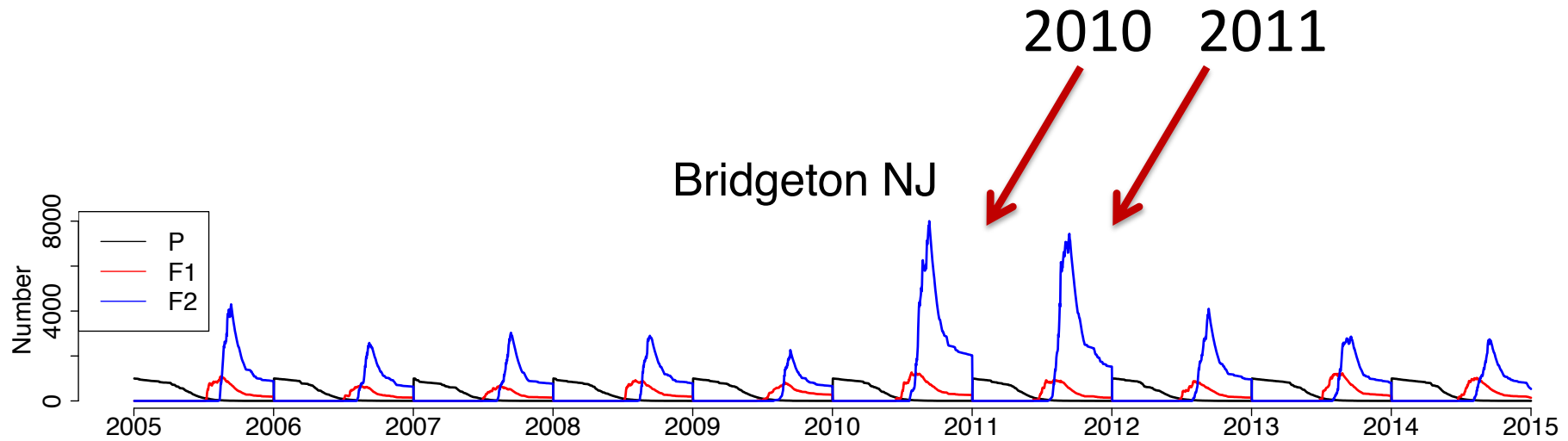
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Image Landsat

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
US Dept of State Geographer

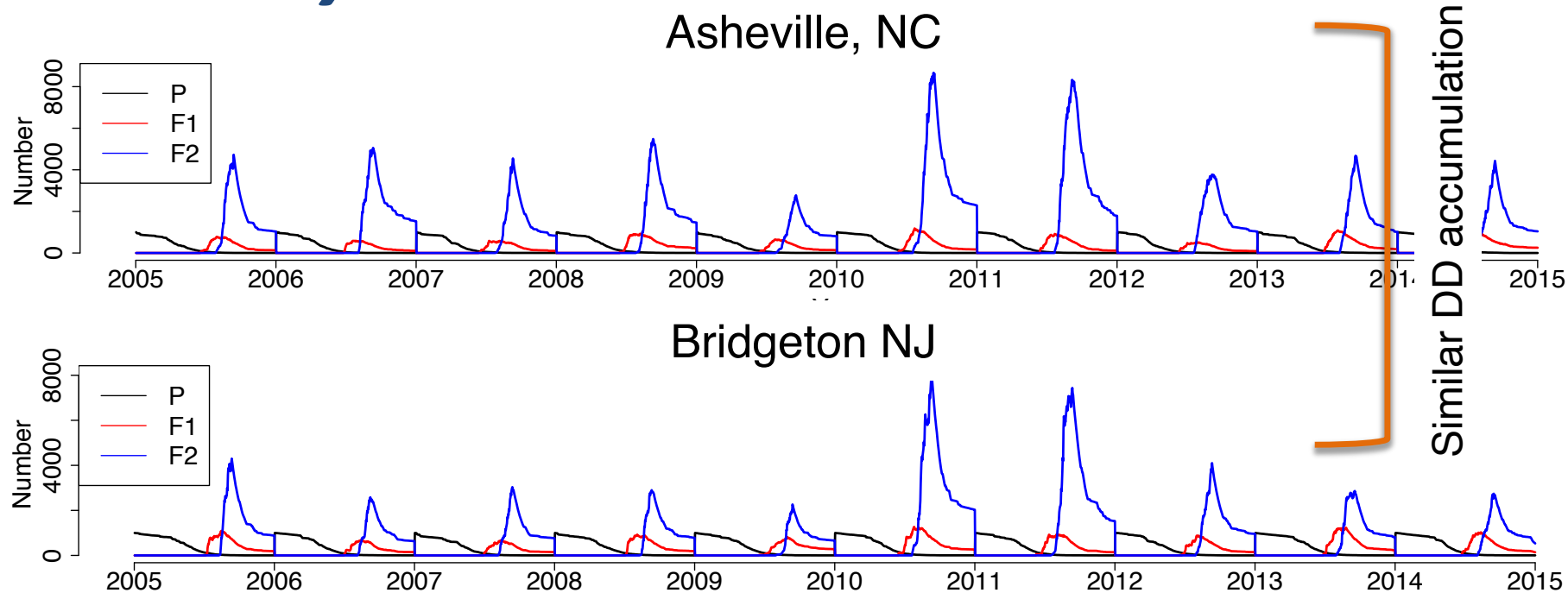
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Population Dynamics in Bridgeton, NJ

Years with high damage and populations had higher simulated populations

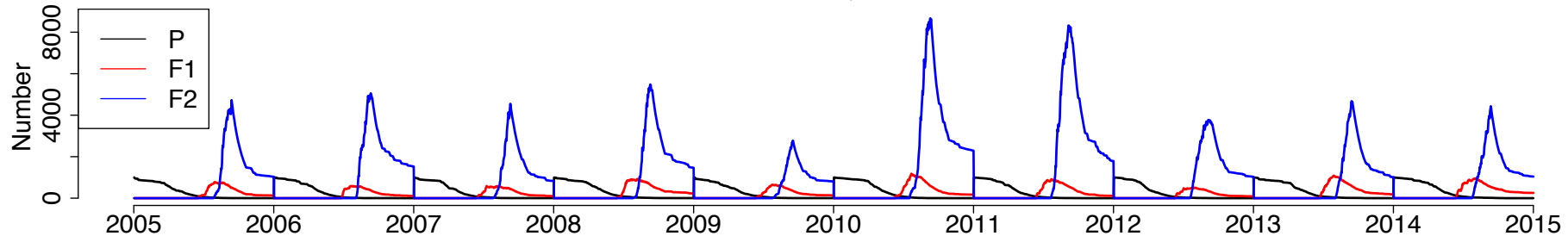


Population Dynamics – Same DD

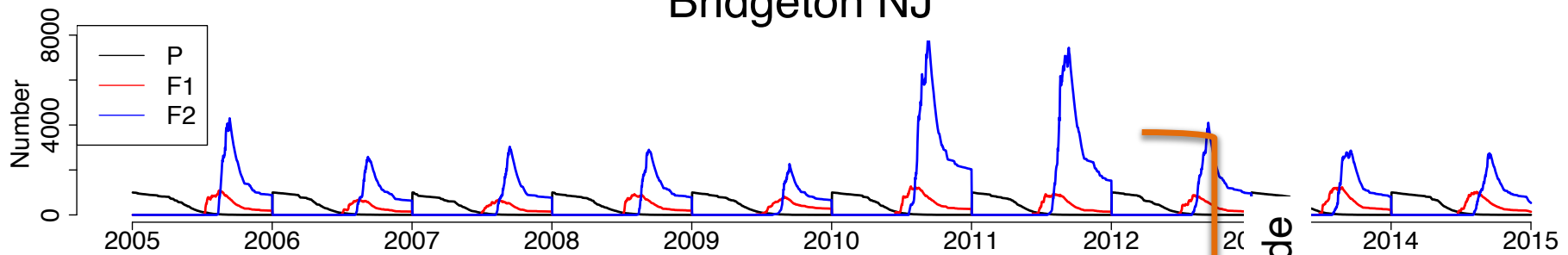


Population Dynamics – Same Biofix

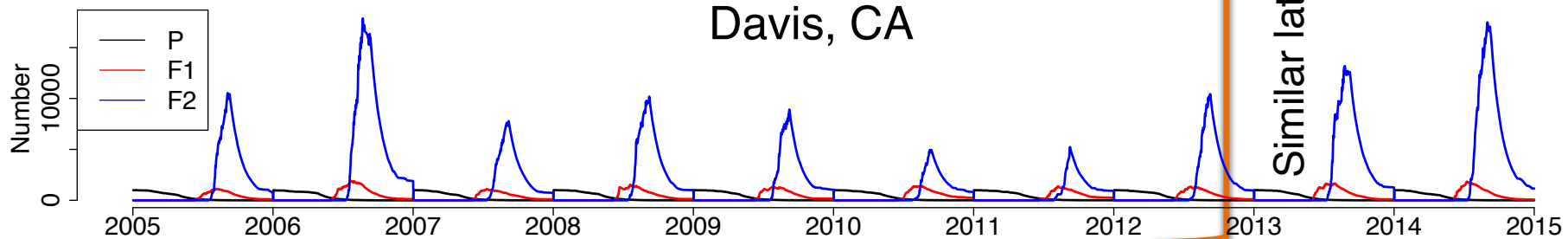
Asheville, NC



Bridgeton NJ

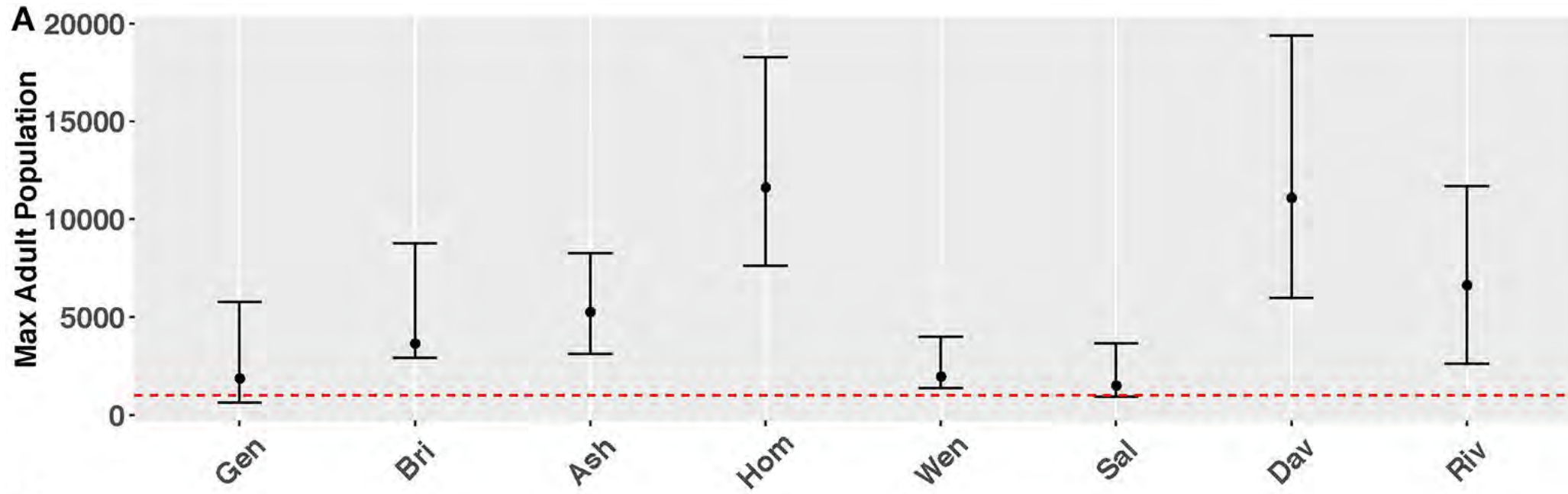


Davis, CA





Adult Population Size, 2005 - 2015



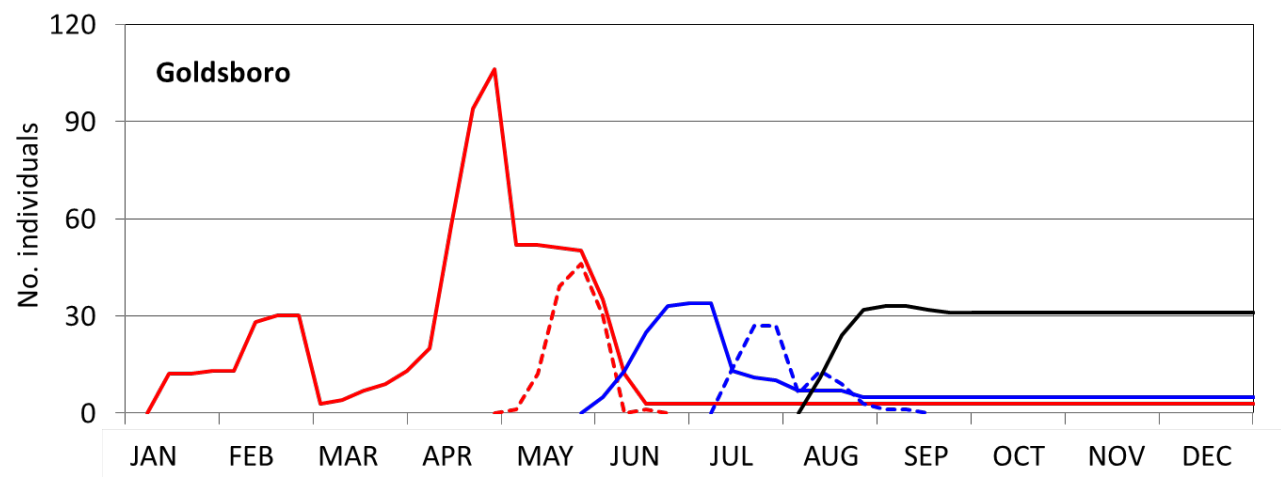
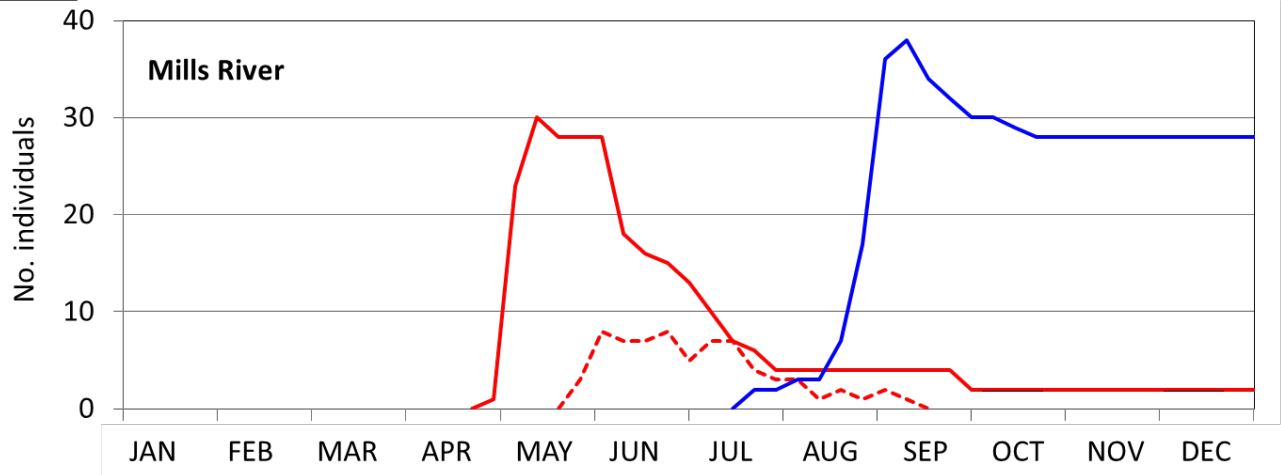
- Differences in stage structure between locations
 - Population size differs between geographic populations
- + Suggests landscape features may play an important role as well as population haplotype

Peak Population Periods in Pheromone Trap Captures and Phenology Model Simulations

State	Adults		Days between population peak dates (vs. phenology models)	Nymphs		Days between population peak dates (vs. phenology models)
	<i>t</i>	<i>P</i>		<i>t</i>	<i>P</i>	
Pyramid trap						
Michigan	2.14	0.1131	16.67	4.88	0.0099	37.67
Maryland	-0.53	0.6301	7	3.02	0.0422	31
Georgia	2.46	0.072	15.67	-0.86	0.4667	20
Oregon	0.92	0.4382	12.33	4.33	0.0444	37
Clear sticky trap						
Michigan	2.14	0.1131	16.67	1.76	0.3051	31.83
Maryland	-0.09	3.9894	1.33	1.66	0.1731	14.67
Georgia	-0.93	0.4417	18	-1.01	0.3937	19.33
Oregon	-1.97	0.1638	27.67	1.89	0.1970	27

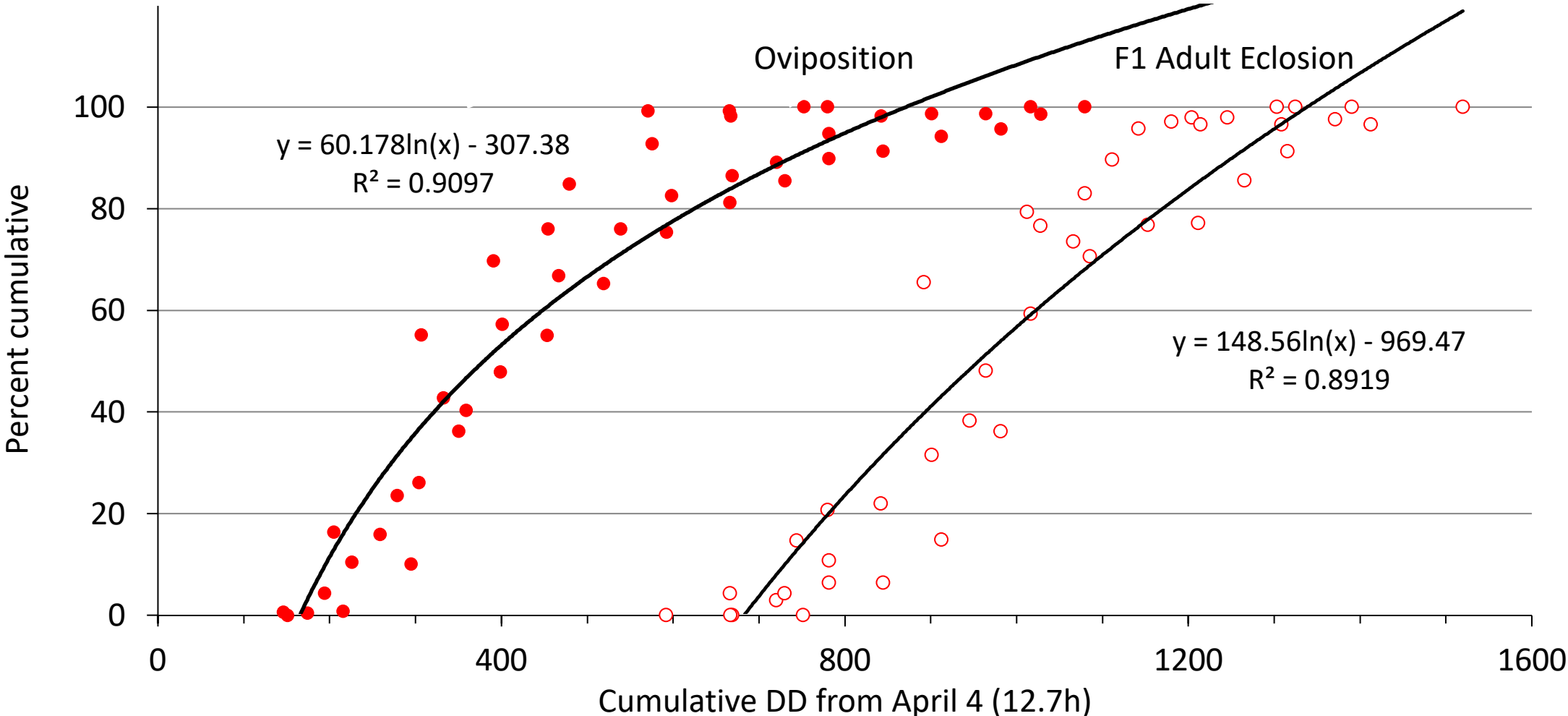
NC State: Number of Living Adults and Eggs Laid

2019

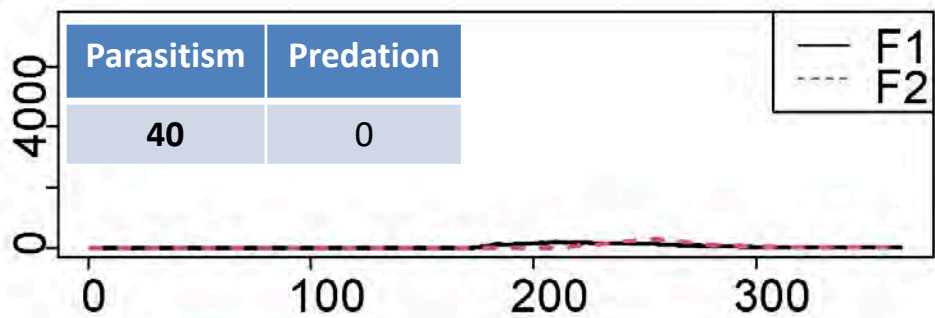
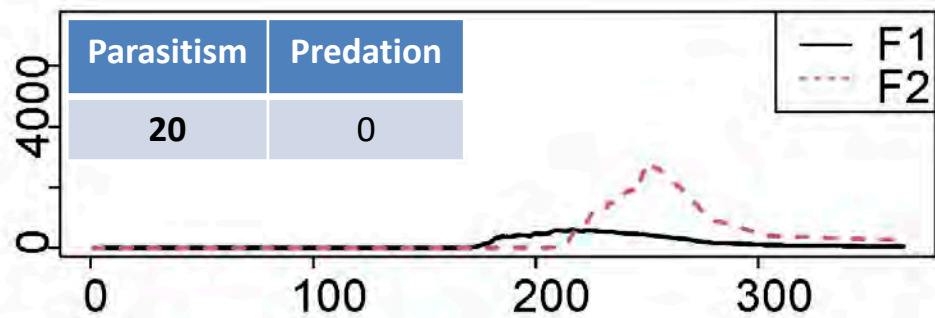
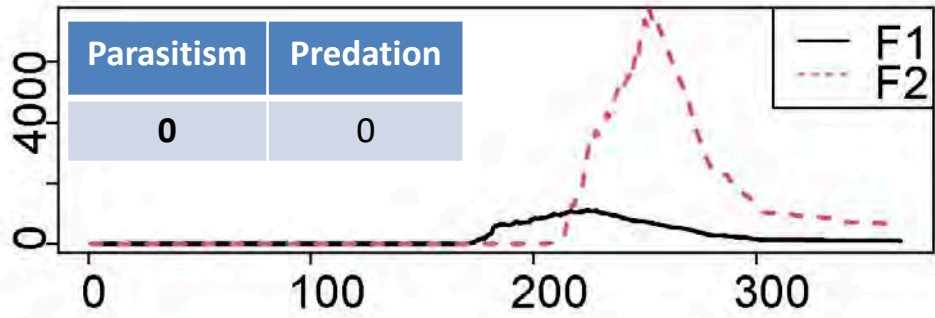


- Empirical model based on developmental data of cohorts of bugs from winter through fall.
 - Western NC (Mills River, 2067 ft elevation)
 - Eastern NC (Goldsboro, 79 ft elevation)
- Using DD accumulations, predicts cumulative oviposition and eclosion of adults from each generation.
- Biofix – Initiation of reproductive development (Nielsen et al. 2017)
 - 12.7 hr photoperiod (4 April in NC)
- Temperature thresholds (Nielsen et al. 2008)
 - 14.2 and 35.6 °C

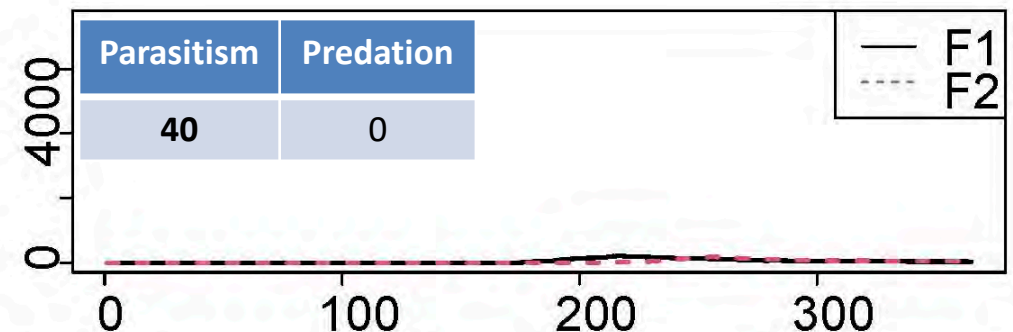
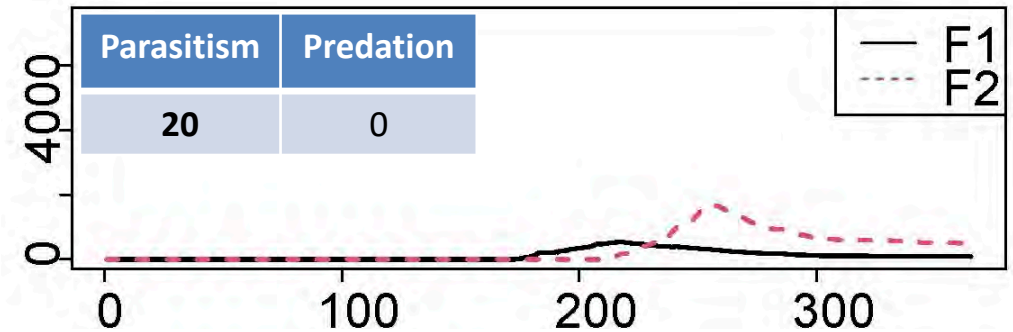
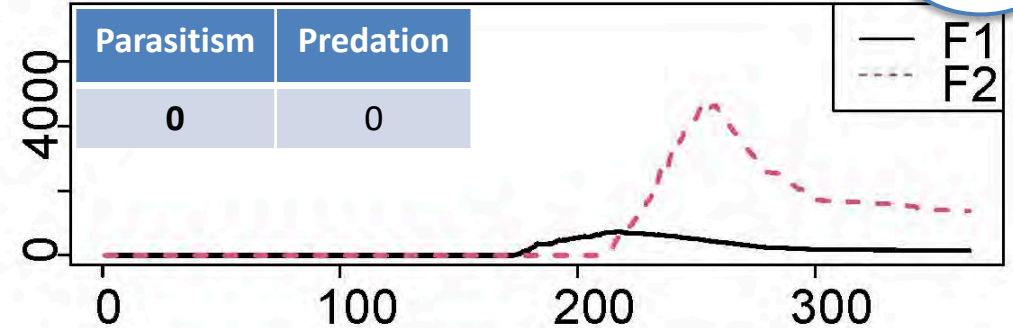
Cumulative Oviposition and Adult Eclosion vs. Degree-Day Accumulations



Bridgeton, NJ 2012 - Adults



Asheville, NC 2012 - Adults



Next Steps

- Incorporate any geographic differences in phenology
 - Overwintering survivorship
 - Critical diapause cues
- Refine impact of biotic factors
- Incorporate landscape influences
- Develop a decision aid system with BMSB model
- Increase parasitism!